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THE MIGRATION OF CHEESE MANUFACTURE IN THE UNITED STATES

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INTRODUCTION

THEORETICALLY, the portion of a dairy region nearest urban markets produces market milk for the nearby cities; the next zone outward in the dairy region produces milk for condenseries, a more distant zone manufactures cheese, and the most removed portion of a dairy area manufactures butter (Fig. 1). In the production of market milk 100 pounds of milk is transported to the city as 100 pounds of weight. Only about 45 pounds of the original 100 is moved to market, however, as condensed or evaporated milk; only about 10 pounds of the original 100 has to be moved when it has been made into cheese, and only 5 pounds of the original 100 must be moved as butter. In gross form, the theoretical pattern occurs in the American Dairy Region. Actually there is considerable overlap among the products, particularly in the zones farthest removed from market, a result of the economics of production in some cases and of the economics of consumption in others; seasonal factors in both tend to overweigh theoretical factors in many cases. This paper briefly sketches the "retreat" of cheese manufacture—its *"westward movement"* through a period of time—from New England to New York, northeastern Ohio, and Wisconsin; the "retreat" or "westward movement" has kept cheese manufacture, in each period, near the outer edge of the American Dairy Region—the portion well removed from urban markets, but not the most-removed area (the butter district). In general pattern, thus, the historical geography of cheese manufacture in the United States has followed the theoretical pattern in gross form, but, until very recently, has remained within the environmental framework of the Humid Continental Short Summer Lands—the agricultural region utilized for dairying. Rhode Island, Connecticut, and Massachusetts were the leading cheese-producing areas of an early day. Cheese production then shifted to Vermont, New York, and the Western Reserve of Ohio as southern New England was invaded by the milksheds of the growing industrial cities. The Mohawk Valley

became the outstanding cheese region of the United States. In turn the New York and Ohio regions fell before the inroads of condenseries and the growing city milksheds, and southeastern Wisconsin became the great center of production. As the Chicago milkshed and numerous condenseries expanded into southeastern Wisconsin, the cheese regions shifted north and west in that state. There are signs now of further retreat in Wisconsin, retreat into Minnesota, and retreat into areas even more distant from urban markets of the present.

COLONIAL MANUFACTURE OF CHEESE

The early settlers of the American East Coast introduced dairy cattle of European origin to the colonies. One phase of American dairying which developed was the farm-kitchen manufacture of cheese. English settlers in New England made cheese from recipes brought from their homeland; Dutch settlers of New York and

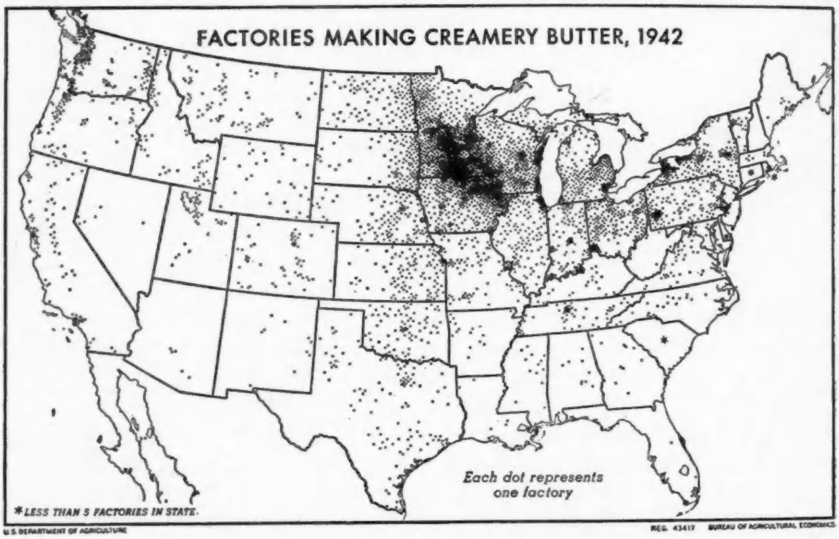

FIG. 1. The map showing location of creameries illustrates this theoretical location. The main butter-producing region of the American Dairy Region is in its outward, or western, portion. This region is known to the trade as the Tri-State Butter Region, and includes Minnesota (chief butter-producing state), northeastern Iowa, and western Wisconsin (United States Department of Agriculture).

German settlers in Penn's colony of Pennsylvania produced varieties of cheese with which they had been familiar at home.

The colonies developed a specialization in agriculture rather early. New England, with its Humid Continental climate, its cool, short summers and stony, glaciated crystalline land increased its emphasis upon dairying, and southern New

England, by the time of the Revolutionary War, possessed considerable dairy specialization. The outstanding colonial region, in both numbers of dairy cattle, and in farm-dairy cheese manufacture, was apparently the Narragansett Basin of Rhode Island, where dairy farms occupied the shorelands around the Bay and the islands of the Bay.[1] Rhode Island was noted for its "Narrangansett Cheese," said to have been the English Cheshire cheese, made from a recipe brought from Gloucestershire, England. There are records of farmers milking 110 cows, and producing 13,000 pounds of farm-dairy cheese during the summer.[2] Near Boston another small area became noted for its "Braintree cheese."[3]

Cheese from Rhode Island and from the dairy farms of southern Connecticut, along the shore of Long Island Sound, was shipped by vessel to the southern colonies and to the West Indies. More than 130,000 pounds of cheese a year entered this trade, quite a respectable total for the period.[4] The cheese was the English cheddar cheese, now known in the United States as *American cheese,* but sold at the time under a regional name, such as Braintree, or Litchfield cheese.

The importance of the southern New England region in dairying is shown by available land utilization figures. For example, in 1796, Connecticut had 21 per cent of its total land area in upland hayfields and pastures, 6 per cent in lowland meadow, and 29 per cent in brushy pasture; only 13 per cent was in tilled crops.[5] Large dairy barns to shelter the cattle and to store hay were built during this period; the New England farm landscape of the nineteenth century had begun to appear.

Farm-dairy cheese manufacture spread to interior New England as these areas were settled, also in pre-Revolutionary times. Litchfield County (northwestern Connecticut) and Berkshire County, Massachusetts, to its north, became leaders in the industry; Windham County (northeastern Connecticut) and Worcester County,

[1] Providence was an important cheese market during late colonial and Revolutionary times. A special book printed for cheesemakers, and distributed from Providence, was: Josiah Twamley, *Dairying exemplified or The business of cheese-making: laid down from approved rules, collected from the most experienced dairy-women, of several countries. Digested under various heads; from a series of observations, during thirty years practice in the cheese trade.* The first American edition, from the second British, Providence, Rhode Island, 1796. (Printed by and for Carter and Wilkinson, and sold at their book and stationery store, opposite the market).

[2] Percy Wells Bidwell and John I. Falconer, *History of Agriculture in the Northern United States,* 1620–1860. Carnegie Institution, Washington, 1925. Some early dairy records, such as 10,000 pounds of cheese having been produced by a farmer from the milk of his 73 cows during a five-month summer period, are mentioned in William Douglass, *British Settlements in North America,* Boston, 1749.

[3] The Town of Goshen in Litchfield County, Connecticut, had attained a reputation for high-quality cheese, and competed in some areas with the Braintree cheese of Massachusetts.

[4] C. W. Larson, L. M. Davis, C. A. Juve, O. C. Stine, A. E. Wight, A. J. Pistor, and C. F. Langworthy, *The Dairy Industry,* Yearbook of the Department of Agriculture, 1922, p. 302. Other early figures of the export trade in cheese from southern New England are mentioned in Tench Coxe, *View of the United States,* New York, 1794.

[5] Bidwell and Falconer, *op. cit.,* p. 120.

Massachusetts, to its north, attained importance. The cheese regions of southern New England consequently were located on both sides of the Connecticut River Valley, on the eastern and western uplands of the three southern states of the region (Fig. 2). A large surplus of cheese was produced. Not only was the trade with the southern colonies and the West Indies continued as manufacture grew, but surplus cheese was shipped by wagon to Boston and to New Haven.[6] From the latter port alone 220,000 pounds of cheese were shipped to New York City during 1801.[7]

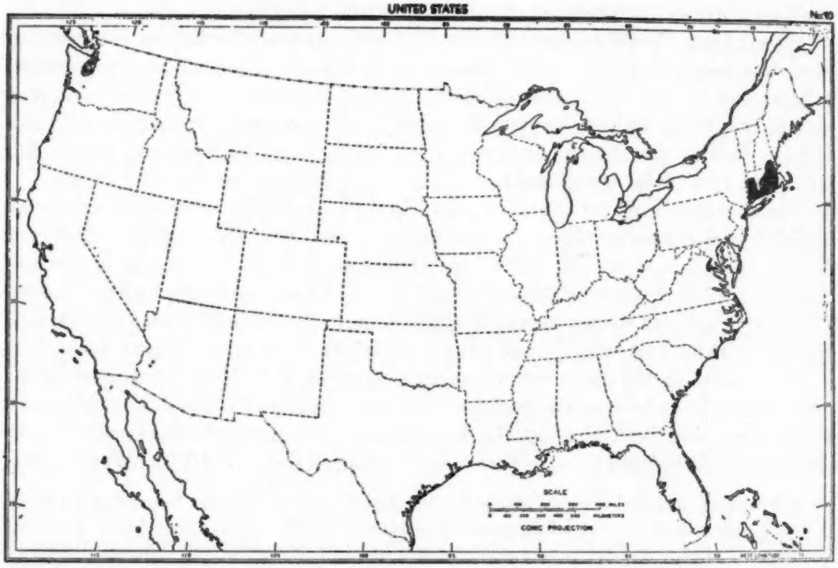

FIG. 2. The main region of farm-dairy cheese manufacture in the United States, about 1800. (Based on Goode Base Map No. 10. Copyright by the University of Chicago. Used by permission of The University of Chicago Press.)

CHEESE MANUFACTURE, 1801–1850

The period 1801–1850 was characterized by 1) the growth of the milksheds of the cities of southern New England, and of New York city; 2) the gradual decline

[6] In 1802, a delegation from Cheshire, Massachusetts, travelled to Washington, and presented a mammoth cheese from Cheshire to President Jefferson. The cheese was transported in a wagon drawn by six horses, and was inscribed "the greatest cheese in America for the greatest man in America."

[7] Bidwell and Falconer, *op. cit.*, p. 139. Other records state that several towns in Litchfield County, Connecticut, and Berkshire County, Massachusetts, "exported large quantities of cheese and grew prosperous in consequence." Quoted from Percy Wells Bidwell, *Rural Economy of New England at the Beginning of the Nineteenth Century,* Transactions of the Connecticut Academy of Arts and Sciences, Vol. XX, April 1916, Chapter V.

of farm-dairy cheese manufacture in southern New England, although it was still important in interior locations at the end of the fifty years (Fig. 3); 3) the rise of Vermont, New York, and Ohio in cheese manufacture; and 4) the beginnings of farm-dairy cheese manufacture in the homes of New England migrants to Michigan, Ohio, Wisconsin, and northern Illinois (Fig. 4). The movement of New

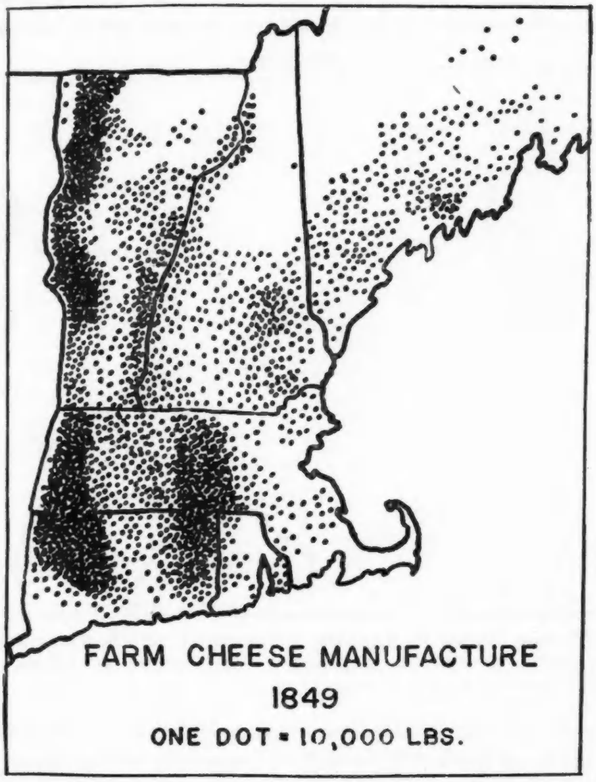

FIG. 3. The manufacture of farm-dairy cheese in New England was a widespread industry of the farm kitchen. The regions of greatest specialization in cheese manufacture were the Eastern Upland of Connecticut and Massachusetts; the Western Upland, including northwestern Connecticut and the Berkshires of Massachusetts; and the Lake Champlain Lowland of western Vermont.

England settlers to Vermont, upstate New York, and the shoreland regions of the Great Lakes helped move the industry westward. The outcries of New England about "competition with the cheap land of the West" (New York in this case) during this period were just as evident in connection with dairying and cheese as

with respect to the better-known complaint about competition in wheat.

New York became the great cheese-producing state (Fig. 5). Farm-dairy cheese manufacture was introduced to the Mohawk Valley by New England settlers. Of three conflicting accounts, one credits a group of settlers from Cheshire, Massachusetts, with the beginnings of cheese manufacture in the town of Fairfield, Herkimer County, in 1785.[8] Another account credits Daniel Day, a settler from the cheese region of Worcester County, Massachusetts, with the introduction of farm-

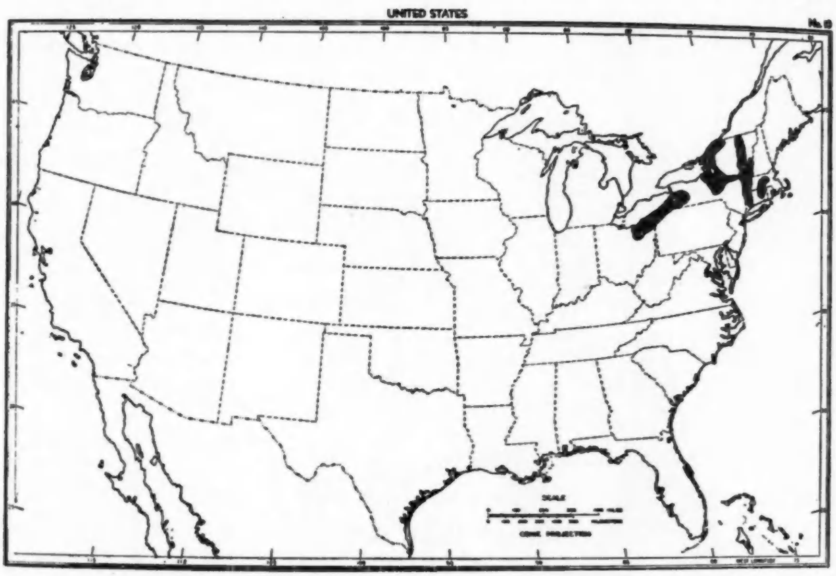

FIG. 4. The main regions of farm-dairy cheese manufacture in the United States, 1850. (Based on Goode Base Map No. 10. Copyright by the University of Chicago. Used by permission of The University of Chicago Press.)

dairy cheese manufacture to Herkimer County in 1808.[9] A third account gives the year as 1810, and states that the settlers responsible for the industry were from New Haven County, Connecticut.[10] In any case, New Englanders transplanted their know-how to the Mohawk Valley, and were the dairymen of Herkimer, Oneida, Montgomery and adjacent counties for some time. One of the early pio-

[8] *Department of Farms and Markets, Division of Agriculture, State of New York, Bulletin 121.* Albany, 1919. p. 183. This statement is in a section written by George A. Smith, Dairy Expert at the New York Experiment Station at Geneva.

[9] B. D. Gilbert, *The Cheese Industry of the State of New York,* United States Department of Agriculture, Bureau of Animal Industry, Bulletin No. 15 (Dairy No. 6). Washington, 1896. p. 7.

[10] *Country Gentleman,* XVIII (1861): 301, quoted in Bidwell and Falconer, *op. cit.,* p. 422.

neers in the Mohawk industry, Mr. Aaron Petrie of Little Falls, Herkimer County, stated in 1841: "All who adopted it (dairying and cheesemaking) flourished at once, and it is another instance of the difference in policy pursued by the descendants and settlers of New England and their Mohawk neighbors ("Dutch and Hessian") that the benefits of dairying were confined to the former for at least

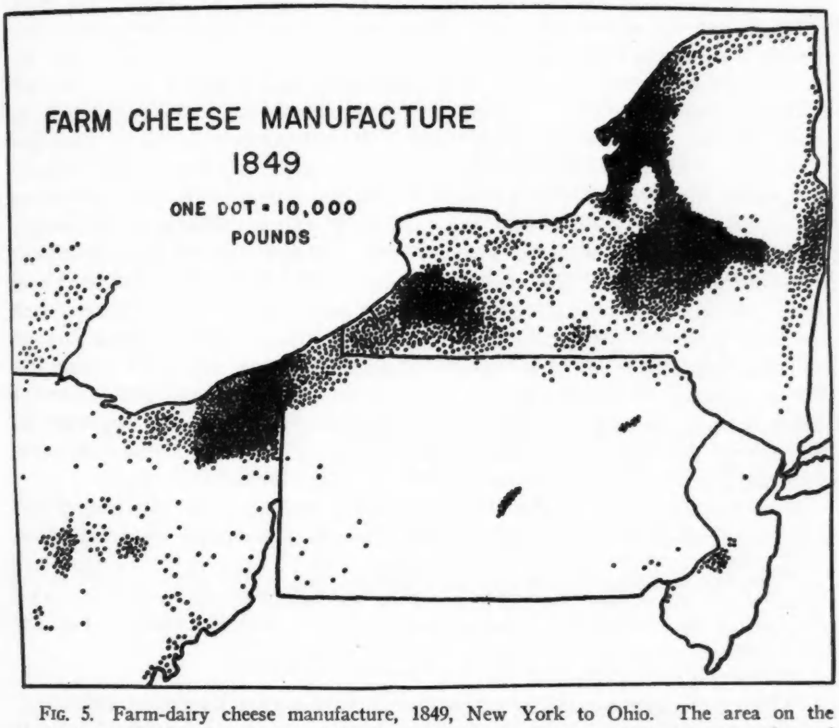

FIG. 5. Farm-dairy cheese manufacture, 1849, New York to Ohio. The area on the upland of eastern New York, east of the Hudson, was contiguous with the cheese regions of western Vermont. Interesting relationships, in addition to those discussed in the accompanying text, were the cheese manufacture associated with the New England settlements in the Wyoming Valley of northeastern Pennsylvania, and the New England settlements in the vicinity of Marietta, Ohio, on the Ohio River. Note the rather sharp southern boundary of cheese manufacture at the southern margin of the Western Reserve of Ohio.

ten years, and indeed until the sterility of the once fertile land of the Mohawk compelled the latter to accept it."[11]

The regions of farm-dairy cheese manufacture in New York followed the areas of New England settlement—the Mohawk Valley proper (between the Adirondack Mountains and the Appalachian Plateau), the Black River Valley west of the

[11] Gilbert, *op. cit.*, pp. 8–9.

Adirondacks, and the lake plains east of Lake Ontario.[12] In time the industry also spread southward, on to the glaciated plateau in the headwater areas of the south-flowing Susquehanna and Chenango Rivers, and into the rugged plateau countryside of extreme western New York, south of Lake Erie.

The Erie Canal, and its feeder canals, such as the Black River Canal, had a profound effect on the localization of cheese regions. The canal provided the route to market, and was admirably suited for the transport of cheese. The countrysides wherein the farmers engaged in the production of farm-dairy cheese were close to the canal or its feeder canals, or along the main wagon roads which provided superior accessibility to the waterway. The importance of the Erie Canal in helping localize regions of cheese manufacture, after its opening in 1825, cannot be overestimated. A few facts will illustrate it. By 1826 "tons" of "English-style cheese" (now called *American Cheddar*) were at the Albany market at the eastern terminus of the Canal. By 1830 the production of Mohawk Valley cheese was great enough to engage the attention of special buyers.[13] Six Mohawk Valley townships shipped over 2 million pounds of cheese on the Canal in 1832.[14] During 1846 the Canal carried 34,534,000 pounds of New York cheese eastward, — or 94 per cent of all the cheese produced in the state that year.[15] The effect of both the New England settlers and the Canal on the stimulation of New York state cheese production was very pronounced. Herkimer cheese, made in the county of that name, attained a quality fame, replacing the Braintree and Litchfield cheeses of New England,[16] by then on the down-slope of production, and, by 1849, Herkimer County alone was producing ten per cent of all of the cheese made in the United States.[17]

New Englanders settled the Western Reserve of Ohio, that northeastern part of the state having been "reserved" for settlement by Connecticut when it ceded its

[12] The lake plains and the glaciated plain *south* of Lake Ontario (known as the Genesee Country during this period) was the center of the great wheat country; the settlers of this area were interested primarily in wheat rather than dairying. Rochester was developing to its early nineteenth century position of a great flour-milling center.

[13] Gilbert, *op. cit.*, p. 11.

[14] Bidwell and Falconer, *op. cit.*, p. 229, quoted from *New York Farmer*, VI (1833).

[15] The New York state census of 1845 reports cheese production as 36,744,976 pounds.

[16] New York cheese interests, like those of Massachusetts during an earlier period, were aware of the value of advertising through presentation of "big cheeses" to notable figures. In 1837 they presented Andrew Jackson, on his retirement from the presidency, with a 1400 pound mammoth cheese—the "biggest cheese in the world." This was cut and eaten at one of Jackson's last receptions. The resulting carnage (not from the cheese alone) was such that it is said to have cost $27,000 to prepare the White House for President Van Buren.

[17] At the first Worcester, Massachusetts, Society Exhibition in 1819 John and David Hunter of North Braintree received the first premium for cheese. From then until 1852 a majority of prizes for cheese went to someone from North Braintree. This town was able to continue its "name" for some time after the Boston milkshed moved to its vicinity. In New York state, during 1849, one-third of the total cheese output originated in the three Mohawk Valley counties of Montgomery, Herkimer, and Oneida.

western lands to the federal government. The New Englanders developed dairying and farm-dairy cheese manufacture in the Western Reserve (Fig. 5). During th 1840's and 1850's it became known popularly as "Cheesedom."[18] A song of the time in the region has the lines:

My baking is spoiling,
My clothes must be boiling
And beef must be broiling
And cheese to make too[19]

So important did farm-dairy cheese manufacture become in this small corner of northeastern Ohio that two of its counties (Ashtabula and Trumbull) joined Herkimer and Oneida counties, New York, as the four most important cheese manufacturing counties of the United States in 1849, and Ohio as a state followed New York in cheese production. More than 9 million pounds annually of Ohio cheese was forwarded via the Erie Canal route to market after first being shipped on Lake Erie to Buffalo. The Canal, for example, in 1846, transported 9,100,000 pounds of out-of-state cheese to market, in addition to its transport of New York cheese. At this time only the Ohio Western Reserve cheese region and adjacent northwestern Pennsylvania lay to the west of New York, and so between a third and a half of Ohio's cheese output must have taken this route to market. Cheese from northeastern Ohio also moved to southern markets via wagon or the Ohio canals to the Ohio River waterway.[20] As early as 1811 over 8500 boxes of cheese, of 60 to 75 pounds each, were rafted past Louisville on the way to markets of the lower Mississippi Valley.[21]

Between northeastern Ohio and western New York, cheese manufacture continued across northwestern Pennsylvania—in Erie and Crawford counties. (Fig. 5). Regionally, there was thus a continuous cheese region south of Lake Erie between Cleveland and Buffalo.

THE INTRODUCTION OF THE CHEESE FACTORY—1851

The first successful cheese factory in the United States was built in 1851 by Jesse Williams, a farmer of near Rome, Oneida County, New York[22] (Fig. 6).

[18] Bidwell and Falconer, *op. cit.*, p. 427.

[19] *The Kraftsman*, IX, No. 3 (May-June 1951). The song was entitled "The Dairyman's Courtship," appeared in 1864, and refers to northeastern Ohio as *Cheesedom*.

[20] W. A. Lloyd, J. I. Falconer, and C. E. Thorne, *The Agriculture of Ohio*, Ohio Agricultural Experiment Station, Bulletin 326. 1918. p. 63.

[21] T. R. Pirtle, *History of the Dairy Industry*. (Chicago: Monjonnier Brothers Company, 1926). p. 160.

[22] The Williams factory was the first successful factory, and the progenitor of "associated cheese manufacture." There were "cheese curd" factories as early as 1847 and 1849 in Trumbull and Ashtabula counties, Ohio, respectively. Some of these manufactured over 1000 pounds of cheese a day (Ohio State Board of Agriculture, *Second Annual Report*, 1847. p. 92). These collected the cheese curd from surrounding farms, and manufactured the cheese, but did not

His factory, opened in May of that year, was on the bank of the Black River Canal, four miles north of Rome, and was operated by water power. Originally the factory used the milk of the 65 dairy cows of the Williams herd and the milk from the cows of his son. Soon milk was purchased from neighboring farms, and "associated cheese manufacture" began. Williams' grandfather had been a dairyman in Connecticut, and "moved" his industry westward.

Cheese factories grew slowly in numbers, despite the success of the Williams factory. Only four factories were built in New York during 1854. By 1860 the total number had risen to 38. Then, during the years 1861 to 1866, 461 new cheese factories were built in New York state alone.[23] Partly this was because the idea had caught on, and the conservative farmers were sure of its success. Partly it was because the cheese buyers preferred the factory-made product, and partly it was the result of a war-induced speed-up during the American Civil War (1861-1865). The cheese factories were all built at or near rural crossroads—the central location to which farmers delivered their milk. *All* were built in existing cheese regions. No new regions appeared—the former farm-dairy cheese areas became centers of rural crossroads cheese factories.

New Yorkers spread the cheese factory elsewhere. The first cheese factory of Wisconsin was built in 1864 at Ladoga by Chester Hazen, a migrant to Wisconsin from New York. A farmer who moved to the Province of Ontario, Canada, from Herkimer County, New York, built one of the first Canadian cheese factories. The first cheese factory of the Province of Quebec, Canada, was built just north of Vermont in 1865. The first factory of northeastern Illinois dates from 1863. By the close of the nineteenth century Wisconsin had a total of 1,227 rural crossroads cheese factories, New York possessed 1,151, Ohio 221, Michigan 130, and Pennsylvania 124. No other state had as many as 100; the United States total was 3,883, of which New York and Wisconsin together contained 61 per cent.

CHEESE MANUFACTURE, 1851–1900

The period 1851–1900 was characterized by 1) the elimination of cheese factories from nearly all of New England, except from the Lake Champlain lowland of Vermont—the section farthest removed from growing urban milksheds; 2) intensification of cheese manufacture in upstate New York, and the regional ex-

start the process with raw milk as a material; these plants had apparently all been closed by 1850. There are records of early factories, which seem to have been discontinued after a short time, near Lake Mills in Jefferson County, Wisconsin, and in Litchfield County, Connecticut. Actually the United States Census of 1860 records only two cheese factories, both in Litchfield County, Connecticut. Apparently the New York enumerators did not list cheese factories; from other records it is known that there were 38 in the state at that time. The 1860 Census records 101 *cheese box factories,* of which 78 were in New York, 14 in Ohio, and 9 in Connecticut.

[23] United States Commissioner of Agriculture, *Annual Report,* 1865, p. 432 and Henry E. Alvord, *Dairy Development in the United States, Yearbook of the Department of Agriculture, 1899.* p. 385.

FIG. 6. The original Jesse Williams cheese factory on the bank of the Black River Canal north of Rome, Oneida County, New York, and the Williams' dairy barn. The drawing is an artist's conception, from an original photograph. Old residents of the area have verified for the accuracy of the illustration. (Courtesy National Cheese Institute).

pansion of the industry into the St. Lawrence River Valley northwest of the Adirondacks; 3) the continuance of the industry in northeastern Ohio; and 4) the rise of cheese manufacture in Wisconsin (Fig. 7).

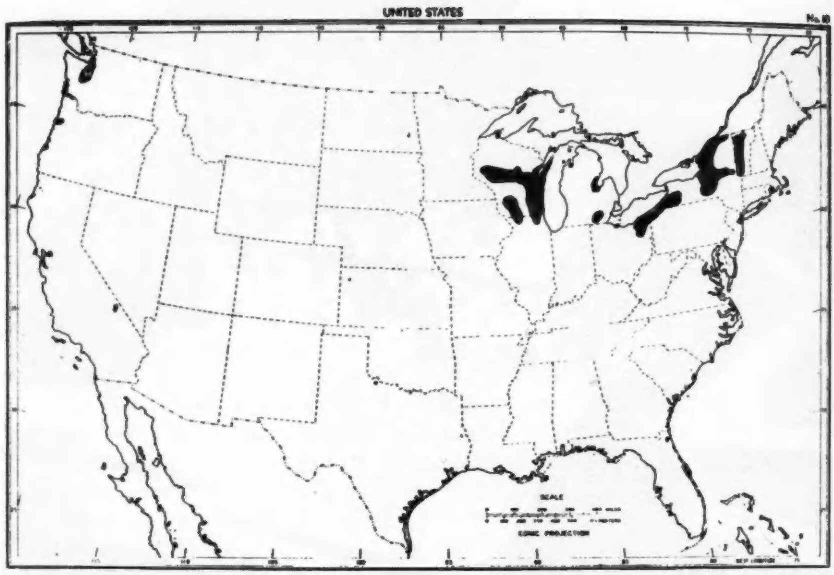

FIG. 7. The main regions of cheese manufacture in the United States, 1900. In addition to the regions within the main American Dairy Region, the Tillamook Valley of Oregon had entered production. (Based on Goode Base Map No. 10. Copyright by the University of Chicago. Used by permission of The University of Chicago Press.)

New York attained its greatest production and market fame toward the end of the period; it was the leading dairy state of the nation. The greatest total number of cheese factories in New York was reached during the 1880's; the high point of cheese production was attained in 1892 (Fig. 8). After this year the decline began. By the close of the period the New York City milkshed, which had previously included only the Hudson Valley, the regions south of the Catskills, Delaware County to their west, and western Long Island, was moving into the Mohawk Valley, and the cheese factories of this valley were beginning to feel the inexorable laws of competition with the urban distributors of milk. Only Herkimer County, which had the market name for quality cheese during this period, was able to compete successfully for a time; but the handwriting was on the wall—Herkimer cheese was on the threshold of following the *name* Braintree cheese, the early quality product of the United States, which had long before disappeared from the markets. New York cheese interests took up the former cry of the New Englanders of the past—

competition with the West—Wisconsin in this case. The seven or eight cheese-marketing centers of New York, of which Little Falls and Utica were the two chief ones, found increasing competition from Plymouth and other Wisconsin centers, and, to their consternation, found "Sheboygan cheese" from Wisconsin competing with their name "Herkimer cheese."

The period 1851–1900 witnesed the rise of cheese manufacture in southeastern Wisconsin and northeastern Illinois. Many of the New England and New York settlers had engaged in dairying and cheese manufacture from the time of their

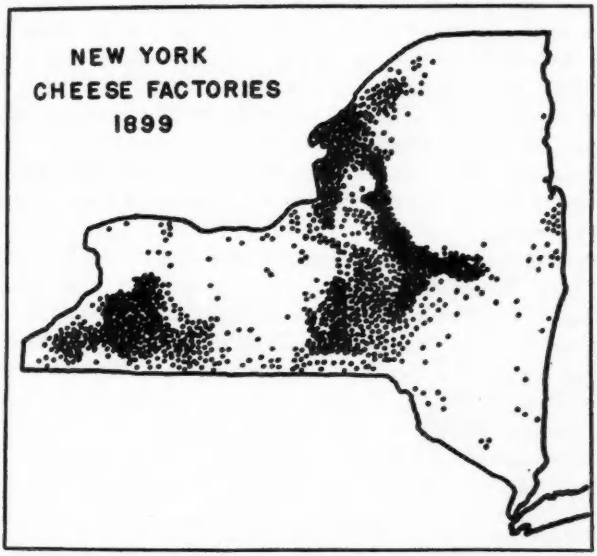

Fig. 8. New York state cheese factories, 1899. These have been located by towns (townships) from records collected by the New York State Department of Agriculture in biennial surveys made during the 1890's. The first "complete" survey of cheese factories in New York was made in 1892. The number of rural crossroads cheese factories in some of the "big cheese" counties during 1899 were: Mohawk Valley—Montgomery 38, Herkimer 105, Oneida 122; Lake Ontario region—Oswego 65, Lewis 80, Jefferson 147, St. Lawrence 162; Upper Susquehanna Valley—Otsego 82, Chenango 86, Madison 66, Cortland 58; western plateau region—Allegany 97, Wyoming 56, Erie 60, Cattaraugus 138, Chautauqua 38.

advent west of Lake Michigan. The rolling glaciated terrain, the cool summers, excellent pasturage, and access to market via the Great Lakes and the newly-built railways, which had reached the area in the 1850's, were factors in the shift from initial wheat production to dairying. In addition several pioneers, such as Governor Hoard, preached for a dairy economy as most suitable to the Wisconsin environment. Four cheese-manufacturing regions, dotted with more than 1000 rural crossroads cheese factories, had developed by 1900. These were the extreme southeast

of Wisconsin and adjacent northeastern Illinois, north and northwest of Chicago; the eastern lakeshore counties of Wisconsin from Milwaukee north to Green Bay; a strip of countryside across northcentral Wisconsin; and the southwestern part of Wisconsin, in the southern part of the Driftless Area (Fig. 9).

The eastern Americans, mainly Vermonters and New Yorkers, introduced cheese manufacture and cheese factories to Wisconsin. They preceded "foreign" settlement into all except the northcentral region, and the Swiss-settled sections of the Green County portion of the Driftless Area. They dominated in numbers in the southeast. However, in the eastern lakeshore region the earliest American settlers were soon submerged in numbers by the German colonists north of Milwaukee, the Bohemians of the Manitowoc area, and others. Nevertheless, New Englanders and New Yorkers started the dairy industry and cheese manufacture; the later arrivals took it up. Despite popular opinion to the contrary, well-documented sources show that the Swiss originally were wheat farmers in Green County. Only after the wheat bubble had burst, and their steep unglaciated hill-country fields had become badly eroded, did they turn to dairying in numbers, and the manufacture of Swiss cheese.

The manufacture of American cheddar cheese was the leading phase of cheese production in the Wisconsin regions during this period. Sheboygan County attained nearly as widespread a county fame for cheddar cheese as the Herkimer area of New York. Plymouth, in Sheboygan County, became the marketing center and price quotation center for American cheese produced in Wisconsin, and the center of a Board of Trade, and to this present day retains its importance in cheese quotations. Wisconsin surpassed Ohio in cheese production in 1880, surpassed New York in total number of cheese factories during the 1890's, and was on the verge of passing New York in total cheese output—this occurred between 1900 and 1910.

CHEESE MANUFACTURE, 1901–1950

The first half of the twentieth century witnessed a marked westward shift in cheese manufacture (Fig. 10). 1) New England lost all of its former importance. 2) By the close of the period nearly all New York state cheese regions except the St. Lawrence Valley, farthest removed from urban markets, were out of important production. 3) The cheese region of the Western Reserve of Ohio succumbed to city milksheds. 4) Wisconsin increased its output, expanded its cheese manufacture areally, and by the 1920's was making three-quarters of all cheese manufactured in the United States, and just over half at the close of the period. Wisconsin cheese attained the fame held earlier, in succession, by the Braintree cheese of Massachusetts and the Herkimer cheese of New York.

The growth of cities in New England resulted in the invasion of New England cheese regions by the urban distributors of milk. The Boston milkshed spread over all of northern New England, and reached into northeastern New York—north of the Adirondacks; the other cities reached to all other parts of New England for milk. Vermont remained outside of the milksheds until the 1920's. Within two

years, 1927 to 1929, it was covered by the rapidly expanding milksheds, and its cheese industry succumbed to the higher prices paid for urban market milk.

New York cheese production fell rapidly after 1900. The New York City milkshed entered the cheese regions of the Mohawk Valley during the early 1900's. By

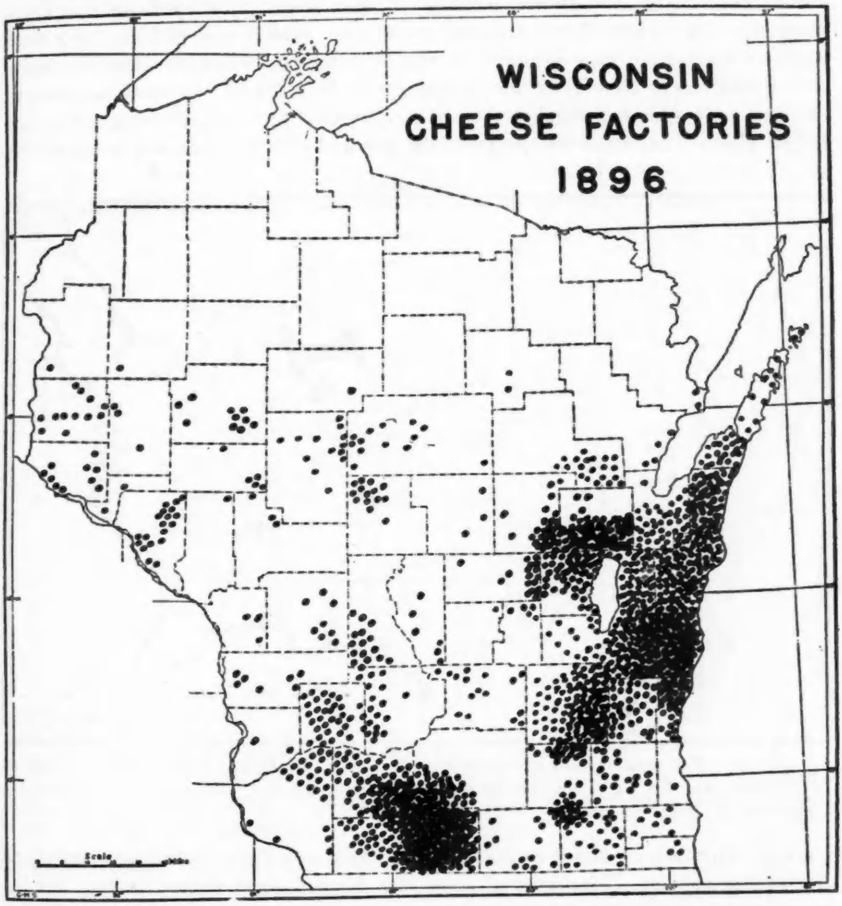

FIG. 9. Wisconsin cheese factories, 1896. The region of greatest concentration in lakeshore Wisconsin centers on Sheboygan County; the Swiss settlements have helped to concentrate cheese manufacture in southwestern Wisconsin, particularly in Green County, but the cheese manufacturing region extends well beyond the limits of Swiss settlement. To its northwest, for example, there were many original "New Yorker" settlements. At this date, cheese manufacture extended south of extreme southeastern Wisconsin into northeastern Illinois—in fact, well toward Chicago (see map, Fig. 9, Loyal Durand Jr., "Dairy Region of Southeastern Wisconsin and Northeastern Illinois," *Economic Geography,* XVI (1940) : 416–428).

the 1920's the milkshed reached almost to western New York. At present all parts of New York state ship milk to the city; some milk originates over 300 miles from the market. Only the St. Lawrence Valley, farthest from market,—not in airline miles, but because it is partly "shut off" by the Adirondack Mountains,—retains a cheese industry of importance, although it, too, ships some fresh milk to urban markets. The former cheese area at the extreme western end of New York state, south of Lake Erie, now is partly in the Philadelphia milkshed. The number of cheese factories in New York has declined from the 1,151 of 1900 to 139 at present; of these only 113 manufacture American cheese (Fig. 11). Although these are larger plants than those of the past, the great decline in numbers is significant.

FIG. 10. The main regions of cheese manufacture in the United States, 1950. (Based on Goode Base Map No. 10. Copyright by the University of Chicago. Used by permission of The University of Chicago Press.)

Factory after factory closed its doors as the urban milksheds moved inexorably into the cheese regions. Herkimer County, the former great cheese center, has but two remaining cheese factories, and these only operate during a two-month flush milk season of May and June.

The growth of the cities of Cleveland, Akron, Youngstown, and others in northeastern Ohio after the turn of the century engulfed the cheese production of the Western Reserve, and the cheese factories of northwestern Pennsylvania succumbed before the inroads of the milksheds of Pittsburgh and Erie. By 1919 the factories had all closed. However, to the south of the Western Reserve the Swiss

cheese region of Ohio remains, with 32 operating factories at present. A small cheese region southwest of Detroit, in Lenawee County, Michigan, disappeared before the inroads of condenseries, and the Detroit milkshed.

The cheese factories of northeastern Illinois and extreme southeastern Wisconsin were eliminated by the growth of the Chicago and Milwaukee milksheds, respectively, between 1900 and 1910. As Chicago grew it was forced to go northward into the dairy regions for a supply of market milk; the dealers could not obtain adequate supplies to the south of the city—the heart region of the Illinois Corn Belt. Here dairying could not compete with the Corn Belt type of agriculture.

Wisconsin became the dominant cheese-producing state of the American Dairy Region after 1900. It surpassed New York soon after this year. By 1910 the

FIG. 11. New York state cheese factories, 1948. The remaining plants are much larger, on the average, than the former crossroads factories. Some are new plants; others are still the same factories, now modernized.

Wisconsin cheese production was larger than New York's had ever been. It reached a total of 363 million pounds in 1925 and 561 million in 1950 (Fig. 12). Relatively, Wisconsin's highest percentage production of the nation's cheese was at its peak in both 1923 and 1927, with 71.5 per cent.

The number of rural crossroads cheese factories in Wisconsin increased from the 1,227 of 1899 to a maximum of 2,807 in 1922. Since that time there has been a decline in number of factories to 1,313 in 1950. However, the remaining factories are of larger size, draw their milk from wider areas, and produce far more cheese per factory than in the past. This reflects improved roads, modern methods of

milk refrigeration, the use of the refrigerator truck for the transport of milk to the factory, and the consolidation of former small plants into larger central plants.

The general movement of the cheese industry in Wisconsin between 1901 and

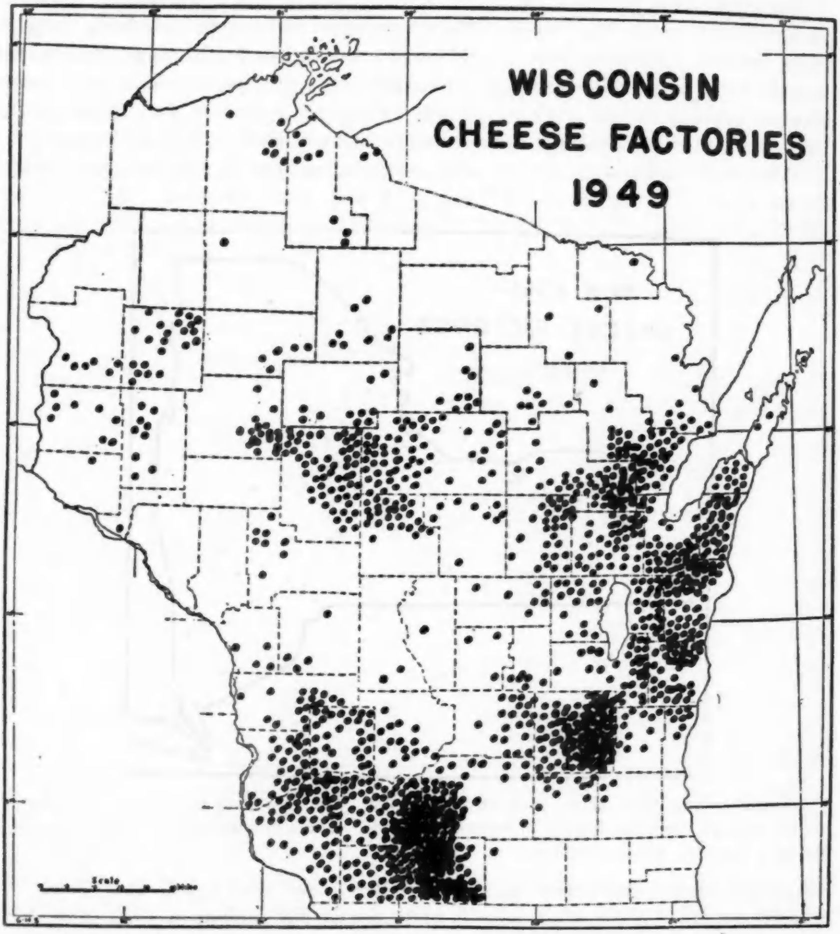

FIG. 12. Wisconsin cheese factories, 1949. The marked northward and westward shift of cheese manufacture in the state is evident, although some of the regions of 1896 (Fig. 9) retain their importance.

1950 has been north and west, away from the expanding Chicago and Milwaukee milksheds. Northeastern Illinois is entirely in the fluid milk area; counties of extreme southeastern Wisconsin, such as Kenosha and Walworth, which were important in cheese production during the 1880's and 1890's, are entirely out of pro-

duction, and in the market milk and condensery zones.[24] Formerly very important cheese counties, such as Sheboygan and Manitowoc, have now been reached by the condensery zone, and the last-named county, by 1950, led the state in the output of condensery products (and its total output was exceeded by only nine *states*). Three of the four leading counties in cheese manufacture in Wisconsin are in northcentral and western Wisconsin, most distant from market milk areas; only Dodge County in the southeast retains an outstanding position on a county basis.

ADDITIONAL CHANGES IN CHEESE PRODUCTION

The westward expansion of cheese manufacture is still continuing in the American Dairy Region. Minnesota, long outstanding in butter production, has witnessed an expansion of cheese manufacture during very recent years. By 1950 some 54 million pounds of cheese were made, not large by Wisconsin standards, but enough to bring this state, at the western end of the Dairy Region, into fifth position in cheese manufacture in the United States (Fig. 13).

West coast cheese manufacture has developed, since 1874, in the cool temperate marine valleys opening to the Pacific in the Pacific Northwest. Best known of these is the American cheddar cheese region of the Tillamook Valley of Oregon. Other valleys in northern California and in Washington engage in the industry.

Modern refrigeration machinery on the farm has permitted the expansion of dairying to some of the warmer-summer climates in the United States,—climates not very important in the industry before 1925. Thus, because of rural electrification in the last 25 years, there has been somewhat of an increase in dairying in parts of the American Corn Belt and in parts of the southeastern United States. Some few areas, particularly in Missouri and Tennessee, possess a cheese industry of recent origin. The total is not large, but by 1950, Missouri was fourth among the states in cheese manufacture and Tennessee seventh.

The expansion to the Pacific Coast, to certain cool irrigated valleys in the American West, to a few localities in the Corn Belt, to the Springfield Platform of the Ozarks of Missouri,and to some southern localities, particularly the Nashville Basin of Tennessee, has lowered the percentage-output of cheese in Wisconsin to just over half of the national total even though that state has increased its actual production.

SUMMARY

Cheese manufacture has moved westward across the American Dairy Region, from New England to New York, northeastern Ohio, and to Wisconsin. This presumably normal westward expansion occurred originally with the westward movement of settlers, particularly New Englanders and New Yorkers. Economically, however, it has been a retreat before the expanding milksheds of the cities of the East Coast and later of the Great Lakes shorelands, and, after the introduction of the condensery, a retreat before advancing condensery districts. "Cheese"

[24] Borden's patent on condensed milk was obtained in 1856. Evaporated milk was first made in "condenseries" in 1885.

in the United States was originally "synonymous" with Rhode Island, and at a later period with New York and with "Cheesedom" of the Western Reserve of Ohio, and at a still later period with Wisconsin. The name Braintree once denoted high quality on the American market; the name Herkimer followed; today the state of Wisconsin advertises its name. Possibly the future pattern will change. Minnesota, at the western edge of the Dairy Region, may succeed to the title; or man himself, through the artificially-induced climates of the milk-cooling room and refrigerator truck, may succeed in developing important cheese regions in localities

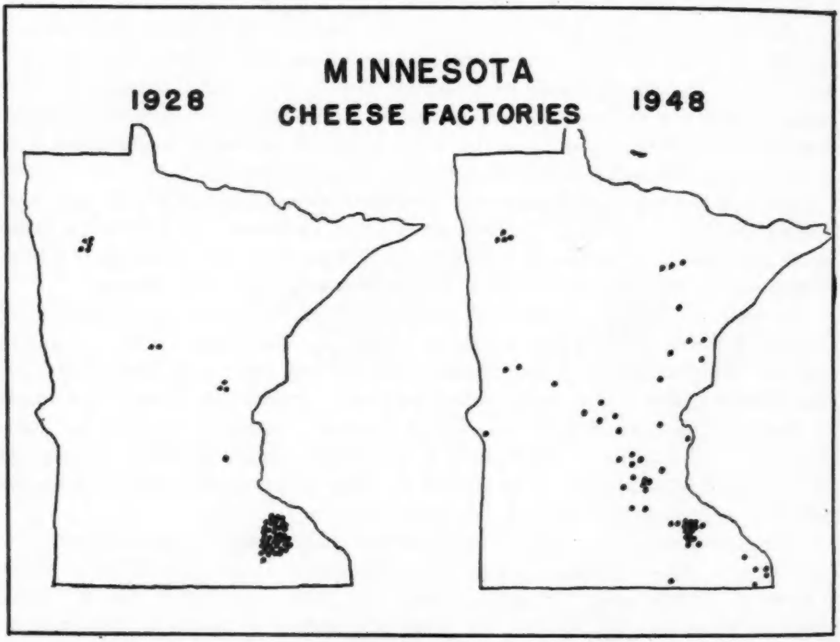

FIG. 13. The "explosion" of cheese factories in Minnesota. The old cheese region, greatly concentrated in part of the southeast, has lost factories as a result of consolidation of numerous crossroads plants. The industry is advancing north and northwest in the dairy regions of the state—into butter areas of central Minnesota, and into developing "cut-over" lands of the northeast.

which were too warm for successful production at one time. In any case, in response to the growing urbanism of the northeastern portion of the nation, milk for cheese manufacture will have to be obtained either through greatly increased milk production per cow in existing producing districts (true of Wisconsin since World War II) or from new and more distant dairy regions. The geography of present American cheese-producing regions will be, in the future, but a period in the entire historical geography of the industry.

THE PLACE OF ORIGIN OF FLORIDA'S POPULATION

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University of Florida

NATURAL increase, i.e., the surplus of birth over deaths, has been a steady source of population increase in Florida. Yet, the very large and rapid increase in population since Florida became a state in 1845—an increase from approximately 70,000 in 1845 to 2¼ million in 1945, a century later—is explained only in small part by natural increase. During this hundred years of rapid growth people have migrated to Florida from many other places in the United States, adding to the population by their own presence and, in many instances, adding native-born Floridians as their own offspring later on.

The first record of place of origin of Florida's population after statehood, the United States Census of 1850, showed that only one-fifth of the total population of 87,445 were Florida-born whites. A larger number (29 per cent) were whites born in other states and a small number (3 per cent) were foreign-born whites. No record was made of place of birth of slaves, who made up nearly one-half of the total population of Florida.

The 1860 Census recorded the place of birth for the free population (white and colored) in more detail than did the 1850 Census, and revealed that the proportion of native Floridians had risen from one-fifth to one-fourth of the total population. The leading places of origin outside Florida were Georgia, South Carolina, Alabama, and North Carolina—all close by. Georgia contributed nearly one-half of the total United States-born from outside Florida; South Carolina contributed 20 per cent; and Alabama and North Carolina, a little more than 10 per cent each. Again, no record was made of the place of birth of slaves.

By 1870 the Census listed place of origin of all whites and colored for the first time.[1] The record revealed that Florida-born persons accounted for more than one-half (58 per cent) of the total population of the State—whites and colored being almost equally divided (Fig. 1).

Georgia, one of the two states adjacent to Florida, had contributed the largest number of out-of-state people to Florida's 1870 population, accounting for approximately 15 per cent of the total population. The other adjacent state, Alabama, was the source of a small number, approximately 4 per cent of the total.

The principle of geographic adjacency apparently did not operate in the case of Alabama since the most important source next to Georgia was South Carolina in 1870 (Fig. 2). It must be pointed out, however, that the chief areas of migration from South Carolina and Alabama—namely, the lower Piedmont area of South Carolina and the central belt of Alabama—were about the same distance from the

[1] *Ninth Census of the United States, 1870: Population.* U. S. Bureau of the Census, 1872, I: 349.

frontier in Florida, which was the north central part of the peninsula. In fact, some parts of South Carolina were closer to the area being settled, especially in terms of the availability of transportation. Moreover, at that time Alabama was still in part a frontier in itself and was gaining population, whereas South Carolina's population was nearly at a standstill, awaiting the rejuvenating force of industrialization that came later. The largest part (65 per cent) of the South Carolinian migration

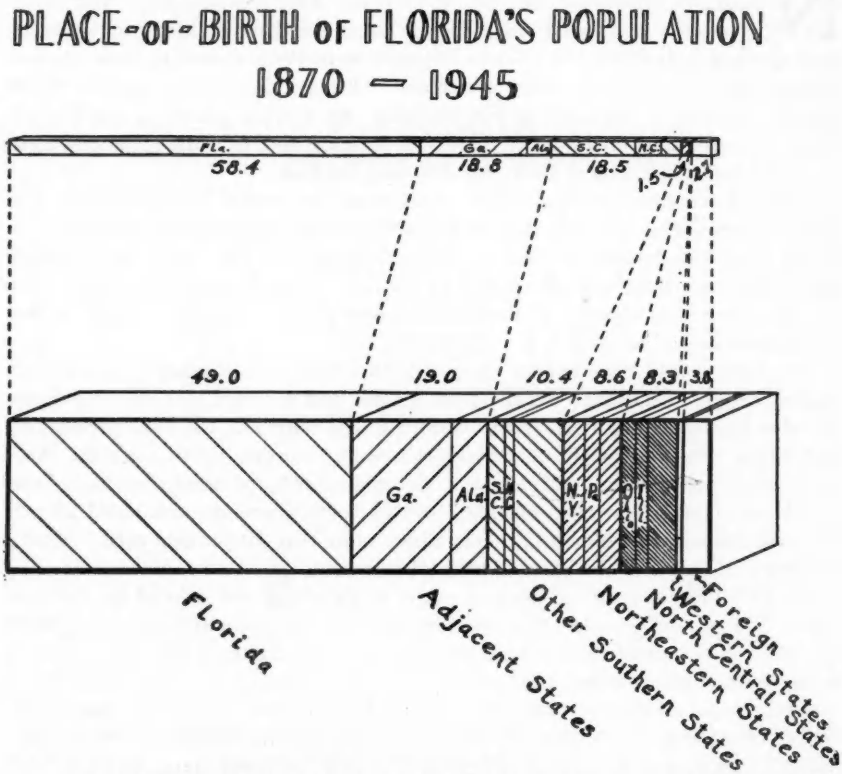

FIG. 1. The noticeable change in place of birth of Florida's population from 1870 to 1945 was the decrease in the proportion of native Florida-born and the large increase in those born outside Florida, particularly in the northern states.

to Florida was colored; many of the colored people were leaving the old plantation areas for the forests and farmlands of the southern frontier after the Civil War. More than half of the migrants from North Carolina and Virginia-West Virginia, the next most important sources of migrants, were also negroes (Fig. 2).

During this early period only a few migrants had come to Florida from areas

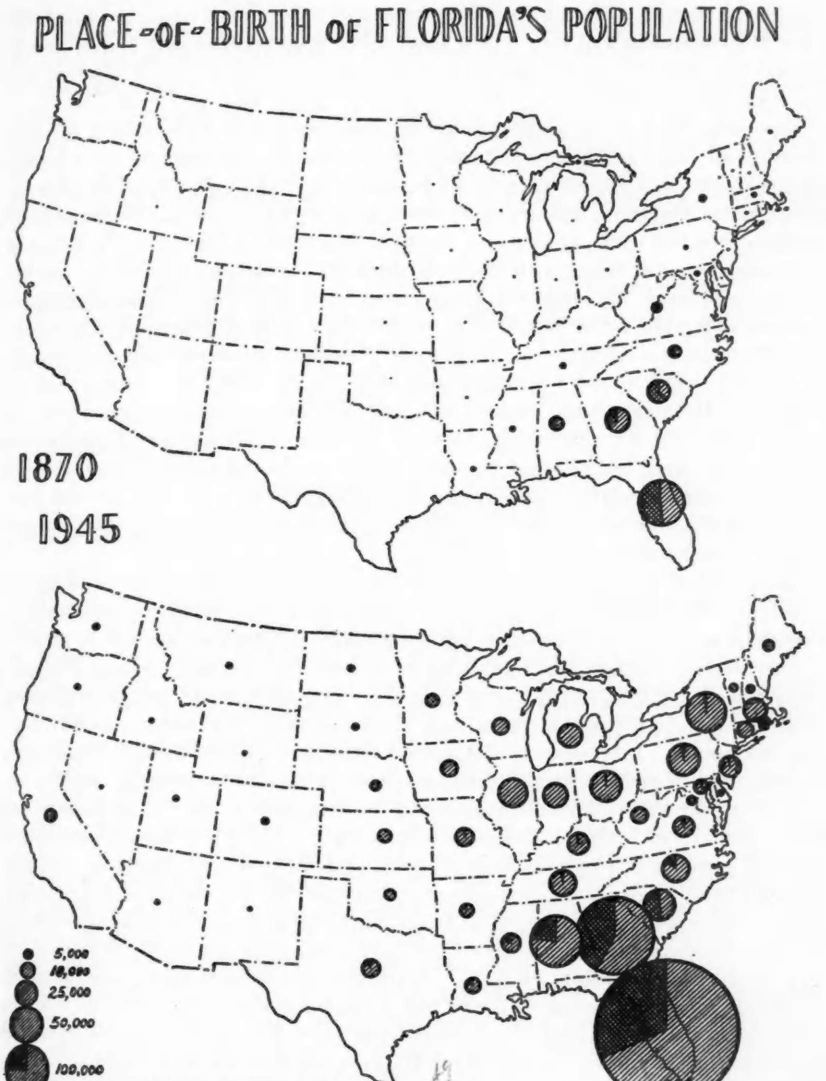

FIG. 2. Two belts with large numbers of migrants to Florida are apparent in 1945: (a) the lower south belt from Alabama to North Carolina, and (b) the northern belt from Illinois to Massachusetts.

outside the South. One thousand had come from New York State, not quite 500 from Massachusetts, and only a few from other Northeastern and North Central states. The Western states contributed five migrants—four from California and one from Idaho Territory.

The sources of Florida's population in 1945, seventy-five years after the first record of all places of birth, were changed somewhat and the numbers were greatly increased from the earlier period.[2] The largest number still were Florida-born, although the proportion had declined from a little more than one-half to just slightly less than one-half (49 per cent) of the total population (Fig. 1). The adjacent states maintained the same percentage of the total population (nearly 19), but the relative position of Alabama was increased and that of Georgia slightly decreased. Since considerably larger numbers of people came from Northeastern and North Central states, the relative position of other Southern states declined from nearly 20 per cent to just over 10 per cent from 1870 to 1945. The Northeastern states, comprising the states from Pennsylvania and New Jersey northeastward, and the North Central States, comprising those from Ohio and Michigan westward to the Great Plains were nearly equal in total, each contributing approximately 8.5 per cent of the total population. Migrants from Western states accounted for less than one per cent of the total. The percentage of foreign-born increased from 2.7 per cent to 3.8 per cent from 1870 to 1945.

The general pattern of place-of-birth of Florida's population of 1945 is the reflection of two principal conditions. The condition of proximity, i.e. nearness to Florida, is especially evident in the Southern states. A regular decrease in number of migrants occurs both north and west of Florida in the states south of Pennsylvania, the Ohio River, and Missouri (Fig. 2). The condition of size of population, i.e. the total populations of states, as sources of migration to Florida, is evident outside the South. The states with largest populations—New York, Pennsylvania, Illinois, and Ohio—have been the chief sources of population outside the South.

A more detailed pattern of place of origin of migrants is gained from an examination of the 1940 United States Census than that for any other time. The Census reported place of residence in 1935 as compared with place of residence in 1940, classified as to residence in cities with more than 100,000 population, in other urban centers, rural-nonfarm residence, and rural-farm residence.[3] In total, the largest number of migrants to Florida were from large cities, although nearly as many were from small cities and towns (Fig. 3). A sizeable portion were from rural-nonfarm residences, largely suburban dwellers, and a smaller number were from farms. In comparison, the destinations of migrants were somewhat different. The principal destinations were cities with less than 100,000 population, although a sizeable number did move to the three large cities—Jacksonville, Miami, and Tampa. A very

[2] *Seventh Census of the State of Florida, 1945.* Department of Agriculture, State of Florida.

[3] *Sixteenth Census of the United States, 1940: Population; Internal Migration 1935 to 1940.* U. S. Bureau of the Census, 1943.

small proportion moved to Florida's farms. In general, then, people moved from one residence-type to the same residence-type—e.g., large city to large city—although a number of variations from this generalization did occur.

An interesting contrast appeared in the sources of migrants to Miami and Jacksonville between 1935–40 from outside the state (Fig. 4). More than one-half of Miami's migrants came from cities of 100,000 or more, whereas less than

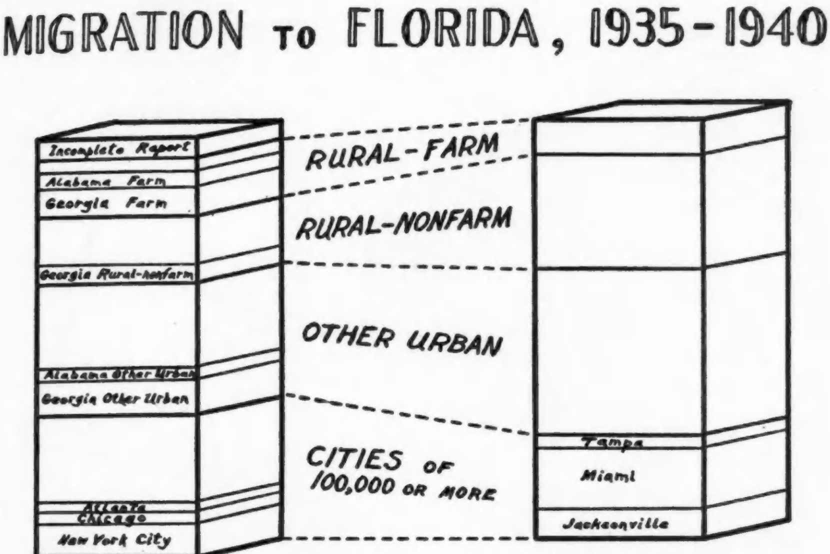

FIG. 3. Migration to Florida in the 1935–1940 period originated largely in cities, large and small, whereas the destinations in Florida (at the right) were more often small cities and rural-nonfarm areas, especially suburban areas.

one-third of Jacksonville's came from large cities. In contrast, a larger percentage of Jacksonville's migrants came from rural areas than did Miami's. The proportion of urban to rural migrants to Tampa was between those of Jacksonville and Miami, and was more nearly like that of Jacksonville.

As mentioned above, the principal category of destinations to Florida in 1940 was urban centers with less than 100,000 population ("Other Urban" in Fig. 4). The chief sources of these migrants to other urban centers were large cities (38 per cent) and small cities and towns (35 per cent), and a fairly large number came from rural-nonfarm areas. The sources of migrants to rural-nonfarm residences—largely suburban areas in Florida—were rather evenly divided among large cities, small urban centers, rural-nonfarm, and rural-farm (Fig. 4). The main sources of

migrants to rural-farm areas in Florida were rural-farm areas in other states, chiefly Georgia and Alabama. Some former urban dwellers did move to Florida farms, but the number was relatively small.

Most of the preceding remarks have dealt with Florida as a unit. A study of place of origin for smaller units—counties—reveals several interesting patterns of distribution of diverse elements of population in 1945. Native Floridians are located in all parts of the State; their distribution conforms nearly, but not exactly, to the general distribution of population (Fig. 5). They form a larger proportion

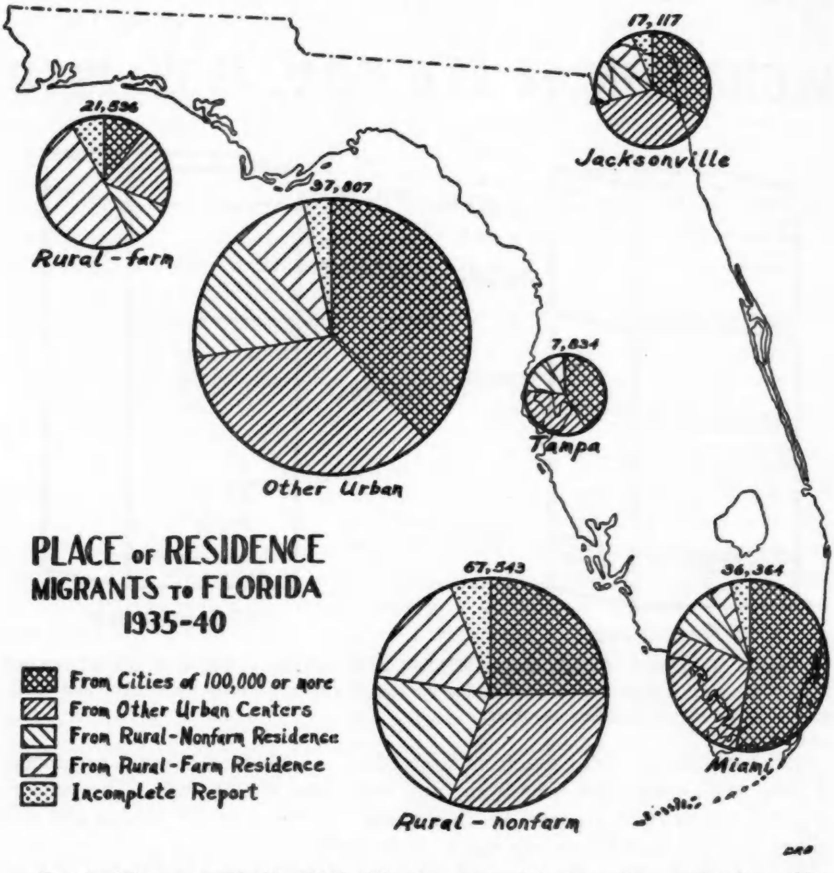

FIG. 4. Migrants to Florida (1935–1940) from large cities generally moved to large cities, but also to other urban centers; those from farms generally moved to farms, although some moved to rural-nonfarm residences, largely suburban.

of the population in the northern and western parts than in the central and southern parts (Fig. 5—inset). The northern and western parts are those that have in general the highest percentages of rural population and of negro population and have shown the slowest rates of growth in recent times—in fact, between 1940 and 1950

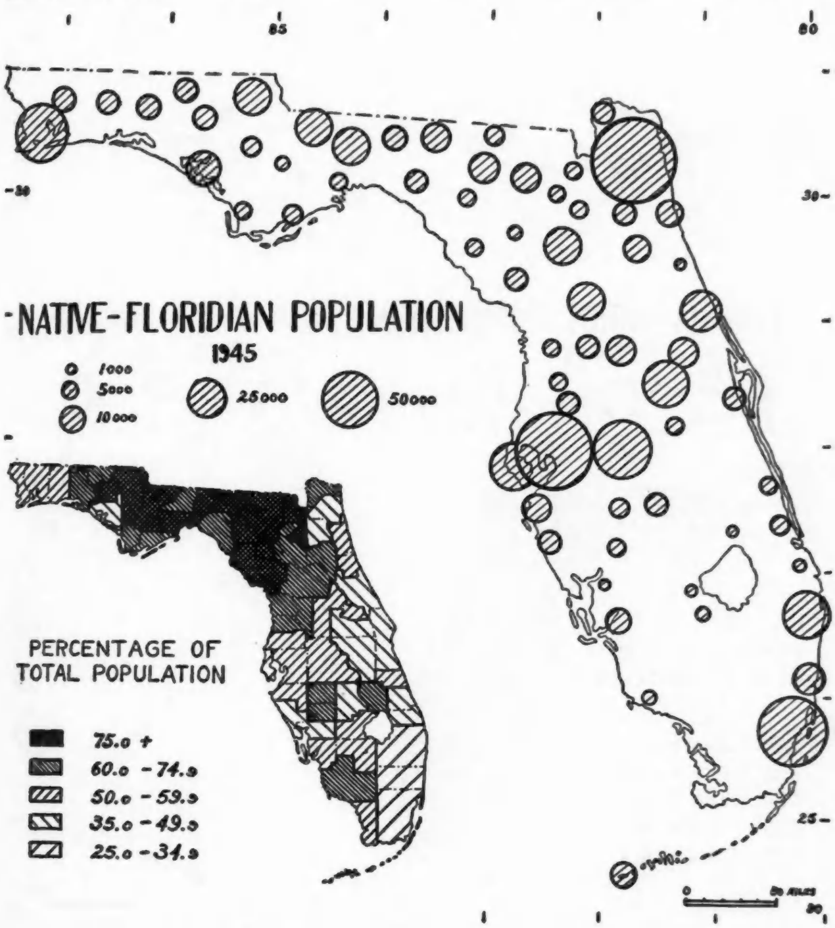

FIG. 5. Northern Florida is the native-Floridian part of the state. The distribution of circles represents county units, graded according to number of people and located as near as possible to the population center in each county.

sixteen of the 36 counties in the northern and western sections actually lost population while the total population of Florida increased greatly. Undoubtedly parts of these sections are overpopulated in terms of their present economies. They are the

oldest-settled sections, in large part a continuation of the forest and plantation-like economy of southern Georgia and Alabama. Although the percentage of native Floridians is less in the central and southern sections of the State, there are large numbers settled there—a reflection of the large total populations in those sections.

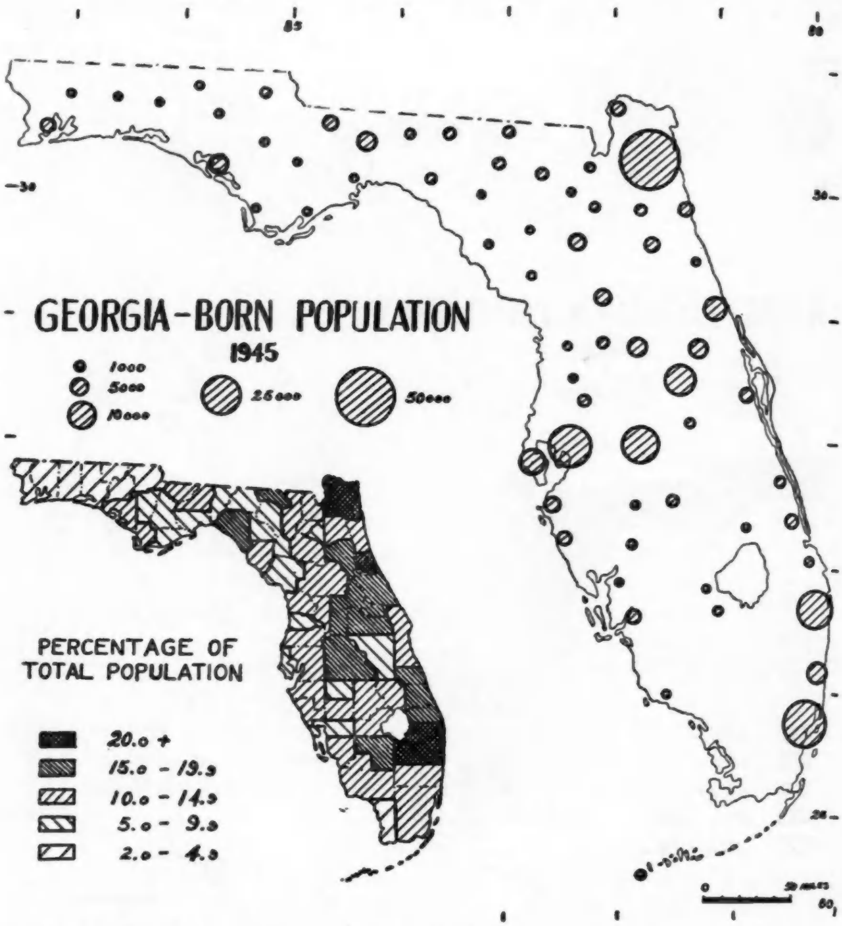

FIG. 6. Georgia-born migrants are noticeably less in the extreme northwestern part of Florida.

The lowest proportion of native to nonFloridian population is in the three counties of the lower East coast and in Pinellas county on the west coast, large resort centers.

Georgians, the largest nonFloridian element in Florida's population, are widely

distributed over the State, and are concentrated in the largest counties (Fig. 6). Jacksonville, being close to Georgia, has the largest number of Georgia-born. In fact, most of the areas adjacent to Georgia in North Florida have a fairly large number of Georgians. In contrast, Georgians are notably lacking in the extreme

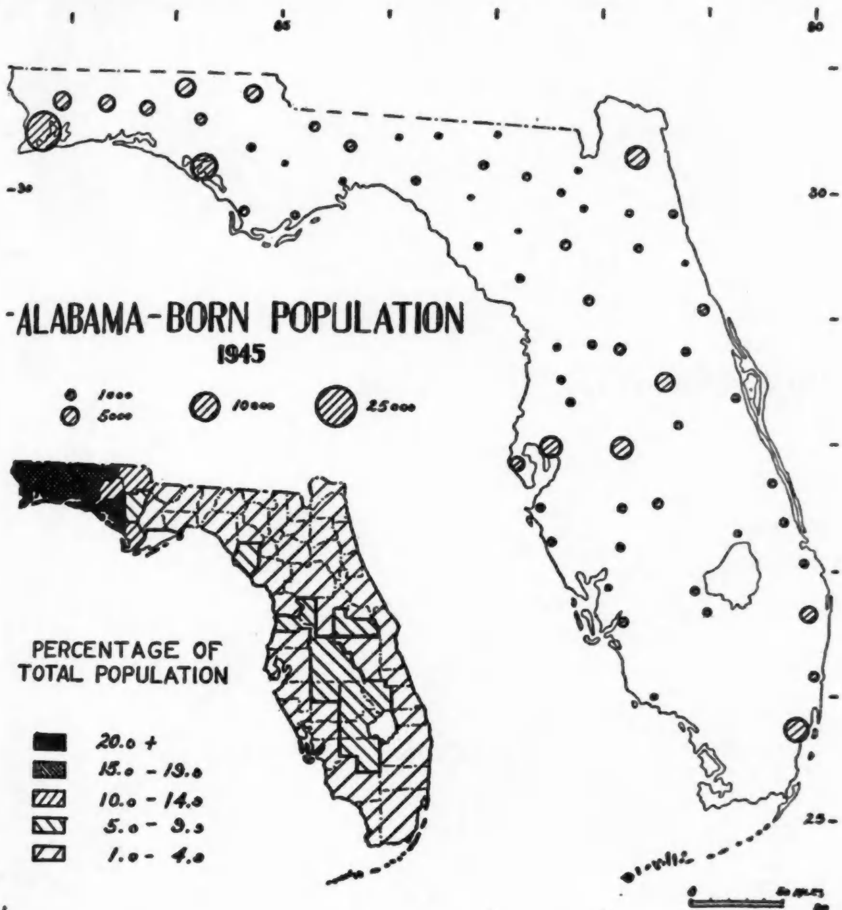

FIG. 7. Alabama-born migrants are concentrated mainly in northwestern Florida, adjacent to the state of Alabama.

western part of Florida, where nonFloridians are largely Alabamans rather than Georgians. Georgians make up less than five per cent of the population in the seven most western counties (Fig. 6—inset).

The notable difference between the distribution of Georgians and Alabamans in Florida is that the Georgians are most numerous in the eastern part, as mentioned, whereas Alabamans are most numerous in the western part—a reflection of proximity to the source of migration. Alabamans have settled in many other parts of the state, but not in such numbers as in the western part (Fig. 7). In

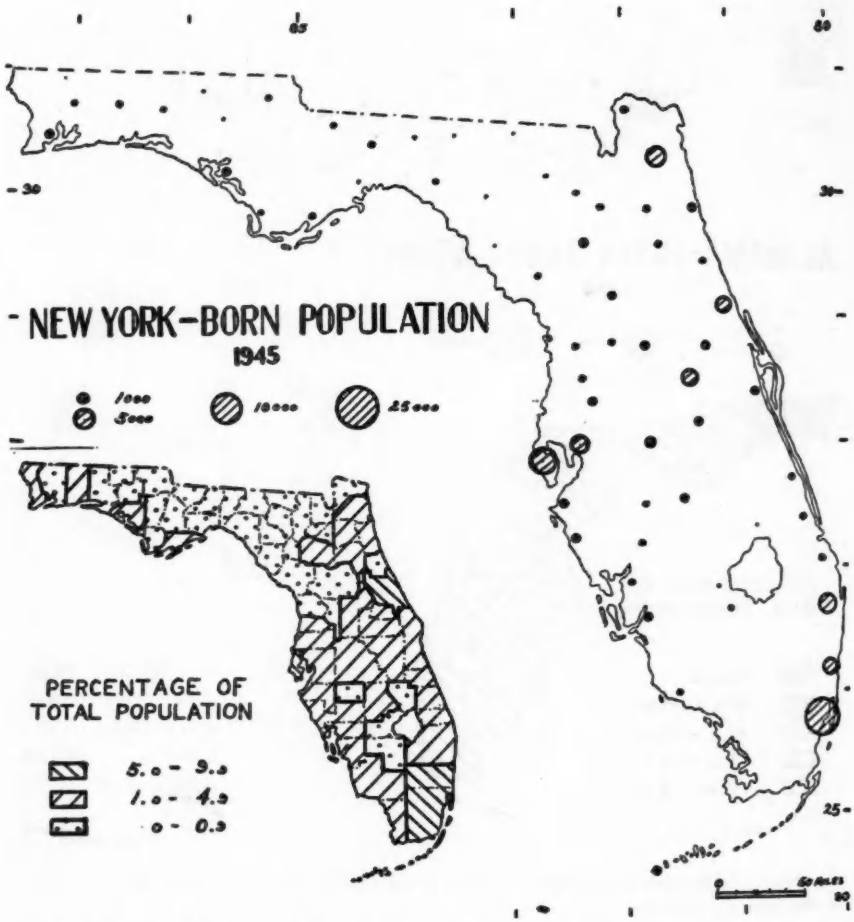

FIG. 8. New York-born migrants are concentrated in the largest resort areas, notably the lower east coast (Miami–Palm Beach), the Tampa Bay area (including St. Petersburg–Clearwater), and the central lakes section northeastward to Daytona Beach.

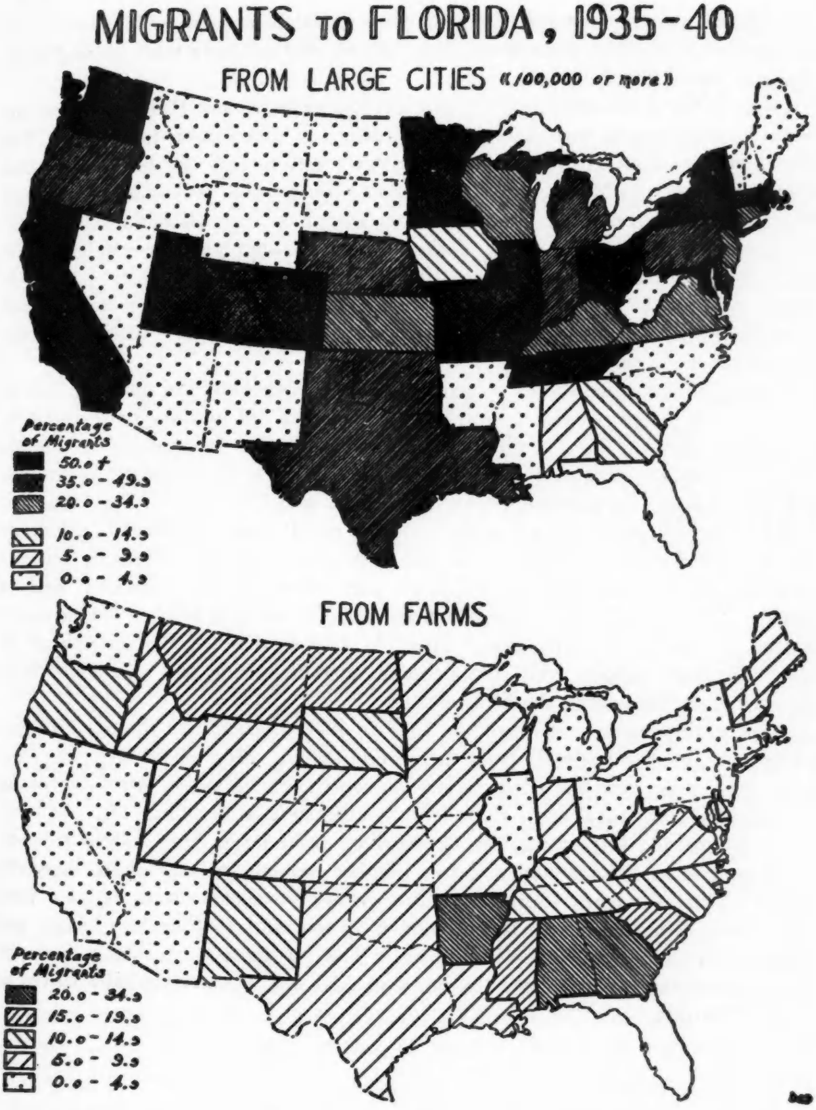

FIG. 9. Most migrants to Florida (1935–1940) from large cities came from the northern states whereas those from rural areas came from southern states.

some of the western counties, the percentage of Alabamans is as high as 25 per cent and nine counties have more than 10 per cent of their total population as Alabama-born (Fig. 7—inset).

New Yorkers, the third largest nonFloridian element, and Pennsylvanians, the fourth largest, have a remarkably similar pattern of distribution in Florida. The pattern conforms closely to the largest resort areas, namely the lower east coast from Palm Beach to Miami, the St. Petersburg-Tampa area on the west coast, and the central lakes section northeastward from Tampa to Daytona Beach on the middle eastern coast (Fig. 8). New York-and Pennsylvania-born are notably less in the Jacksonville area of northeastern Florida in proportion to the total population than in central and southern sections of the State. Most northerners have retired to or established businesses in the most recently-settled sections—namely, the central and southern parts.

Having thus defined the three main patterns of distribution of nonFloridians in Florida, most of the remaining nonFloridian-elements fall into one or the other of the main patterns. The Georgian-type, i.e. concentration in northeastern Florida and in central and southern Florida to lesser degree, is characteristic of the distribution of South Carolinians, North Carolinians, and Virginians. The Alabaman-type, i.e. concentration in northwestern Florida and to lesser degrees in central and southern Florida, is characteristic of the distribution of Mississippians, and less markedly of Tennesseeans, Kentuckians, and other Southern peoples west of Florida. The New Yorker-Pennsylvanian-type, i.e. concentration in southern and central Florida, particularly resort areas, is characteristic of the distribution of other Northern peoples from the populous manufacturing belt extending from southern New England to the Midwest.

Finally, the detailed record of the 1935 to 1940 migration to Florida furnishes evidence of types of migrants from the several states. Most of the migrants from large cities came from the northeastern and north central states, whereas most of the migrants from rural areas came from southeastern states (Fig. 9). As mentioned before, the largest number of migrants from large cities moved to small urban centers in Florida with a lesser number moving to large cities, especially Miami. Thus, the many former big-city dwellers from such places as New York City, which furnished nearly 10 per cent of all migrants to Florida, Chicago, and Detroit moved to small cities in Florida. The former farm residents from the southeastern states, particularly Georgia and Alabama, characteristically moved to farms in Florida.

PEDIMENT CHARACTERISTICS AND TERMINOLOGY

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Louisiana State University

OBJECTIVES

PLANATE bedrock surfaces, *rock pediments* and *rock benches*, form a large proportion of the comparatively flat relief elements of arid and semiarid landscapes. The origin of these landforms has been controversial since Gilbert first recognized and described them[1]. More than seventy years of subsequent research has produced a variety of terms, descriptions, and theories of development. An objective appraisal of this body of material is warranted at the present time.

Analyses of the published descriptions reveal the apparent universal nature of some of the physical characteristics of the pediment. Herein attention is focused on such diagnostic criteria. The terminology generally used to designate the erosion surface is examined with purpose to select the most appropriate terms. In this respect terms suggesting genesis are avoided, emphasis being placed rather on geomorphic location. It is further suggested that the condition of alluviation of the bedrock surface, a criterion of significance as to mechanics of truncation, may be employed to qualify the feature further.

Two major theories of origin have proven acceptable to students of this subject. One proposes that rock planation is a result of lateral corrasion by steep-gradient, ephemeral streams; the other contends that weathering of escarpment faces causes their retreat, leaving as a consequence a relatively planate bedrock surface. Some recent workers have combined certain tenets of these two concepts. The present writing is not concerned with an evaluation of hypotheses. The intent is rather to offer a summarization of physical characteristics and terms. A summary tabulation of 43 works pertinent to the subject is arranged in an appendix for this purpose.

PART I*

PEDIMENT CHARACTERISTICS

Climatic Restrictions

Although rock truncation occurs in all climatic regimes, its most widespread effect, the *pediment*[2], is common to the dryland region. The *rock bench* and the *pediment* are genetically similar, distinction between the two being that of areal extent. It should be emphasized that no special weathering or erosional process

[1] Grove Karl Gilbert, "Report of the Geology of the Henry Mountains, Utah," *United States Geographical and Geological Survey of the Rocky Mountain Region* (1880): 120–127.

[2] This term was first used by W J McGee, "Sheetflood Erosion," *Bulletin, Geological Society of America*, VIII (1897): 92, 110.

* Part II of this paper will be published in the March 1953 issue of the *Annals*.

is exclusive to the arid setting. The more widespread development of the rock plane in the latter environment results largely from an optimum combinaton of atmospheric factors. It is the dry atmospheric regime which embodies the most suitable combination of climatic factors for the extended leveling of rock surfaces. This combination is altered in effectiveness by variations in its climatic components. An increase in humidity, for example, ordinarily (but not invariably) decreases the capacity of the regime for production of truncation processes of widespread scope. The efficiency of the rock truncating processes are, of course, directly influenced to varying degree by such factors as lithology, rock structures, and structural activities, each of which may locally or regionally assume a dominant role.

The arid climatic equation which engenders pedimentation includes as prominent components a low rate of annual precipitation, relatively high evaporation conditions, and extended intervals of above-freezing temperatures. High evaporation rates may be maintained by high temperature and moderate winds, or even by low temperatures (above-freezing) and relatively high winds, if the annual rainfall incidence is low. Moreover, the semiarid condition may be maintained in regions of quite moderate rainfall by prevailingly strong, dry winds. The gamut of locales for pediments and pediment-like landforms ranges from the hot dry regions, through the cooler, more temperate deserts, and into both the hot and cool (but relatively dry) semiarid regions peripheral to deserts. It is not the purpose of this writing, nor is it within the capabilities of this writer, to present a detailed analysis of the complex of atmospheric controls which may combine in varying proportions to produce pedimentation. Suffice it to say that in the majority of instances the pediment is described as occurring in regions of *low annual rainfall, moderate to high mean annual temperature,* and *relatively low humidity.*

Physiographic Setting

The pediment has been described most often as associated with mountain ranges, usually as a piedmont feature. The appendix accompanying this writing includes forty-three outstanding descriptive works, the majority of which note occurrence in that setting. However, the arid and semiarid climatic regime is not restricted to mountainous regions. Widespread areas of beveled rock terrain make up a major portion of the practically featureless dry plains and plateaus of Australia[3], Mongolia[4], British East Africa[5], South Africa[6], Northern Nigeria[7], and Mozambique[8], to men-

[3] J. T. Jutson, "Erosion and the Resulting Land Forms in Subarid Western Australia, Including the Origin and Growth of the Dry Lakes," *Geographical Journal,* XL (1917) : 418–437.

[4] C. P. Berkey and F. K. Morris, "Geology of Mongolia," *Natural History of Central Asia,* II (1927) : 323–351.

[5] G. L. Collie, "Plateau of British East Africa," *Bulletin, Geological Society of America,* XXIII (1912) : 297–316.

[6] L. C. King, *South African Scenery.* (1942), pp. 116, 267.

[7] J. D. Falconer, *Geology and Geography of Northern Nigeria.* (1911), pp. 1–62, 194–266.

[8] A. Holmes and D. A. Wray, "Mozambique, A Geographical Study," *Geographical Journal,* XLII (1913) : 143–152.

tion some of the non-mountainous habitats. It is true that in many regions the broad planation surfaces represent the truncation and destruction of formerly mountainous terrain, isolated residuals of which may be found projecting above the surfaces. It is also true, however, that widespread planation has developed in regions of non-mountainous structural character.

The bedrock erosion surface is most commonly found along the base of a steeper slope or an escarpment. This may be, as is the case in the majority of the listings in the table, a steep, abrupt mountain escarpment of relatively great relief, or a prominent plateau escarpment such as in the Colorado Plateaus of western North America[9]. On the other hand, pediment-like features have also been described along the valley sides in the High Plains of eastern Colorado and Kansas[10], the relief contrasts in this instance being only moderate.

Bryan has stated[11] that ". . . the position of the area with regard to the sea, both in distance and in altitude, is a controlling influence" in the development of the pediment. It is quite true that there is a general tendency toward greater aridity with increased distance from the sea. It is not true, however, that the arid or semiarid regime is always an interior one. The drylands of northern Africa, southwestern Asia, Australia, and eastern and western South Africa are closely marginal to the coast. Moreover, widespread beveled rock surfaces occur in these regions. Nor can the factor of altitude be a prime control inasmuch as the erosion level has been observed at altitudes ranging from a few hundred[12] to more than 10,000[13] feet above sea level. The factor of baselevel control, whether climatic or due to local geologic circumstances, is not directly dependent on altitude or distance from the sea. In the indirect sense, however, it is likely that the greater incidence of planation activity in interior locations may result from an increase in aridity in this sense, along with the increased opportunity for the development of local baseleveling effects with greater distance from the sea. Similarly, since elevations increase ordinarily (but not always) toward the continental interiors, interior pediments usually occur at higher elevations. The possibility of orogenic or epeirogenic uplift of the planated region, however, must not be overlooked. It appears probable, as suggested by Howard[14], that the so-called *peneplains* of the Rocky Mountain region actually represent a general accordance of level produced by pedimentation, considerable uplift having occurred since the leveling took place.

[9] O. E. Childs, "Geomorphology of the Valley of the Little Colorado River, Arizona," *Bulletin, Geological Society of America,* LIX (1948): 353–388.

[10] J. C. Frye and H. T. U. Smith, "Preliminary Observations on Pediment-like Slopes in the Central High Plains," *Journal of Geomorphology,* V (1942): 215–221.

[11] Kirk Bryan, "The Formation of Pediments," *Report of the XVIth International Geological Congress,* II (1936): 768.

[12] Jutson, *op. cit.*, p. 419.

[13] Observed by this writer in the Front Ranges of the Colorado Rockies.

[14] A. D. Howard, "Rocky Mountain Peneplanes or Pediments," *Journal of Geomorphology,* IV (1941): 138–141.

Areal Extent

The *pediment* has been described as ranging in size from miniature features measured in feet[15] to broad levels of planation covering many square miles[16]. The extent of development of the erosion surface is, as noted by Bryan[17], in large measure "spatial." The latter observed that "Large basins and small mountain blocks are . . . primary patterns, which later erosion may find it difficult or impossible to modify." The *pediment,* however, is not restricted in occurrence to a mountainous topographic setting, being common to low and moderate relief terrain as well. The more fundamental control of extent of the erosion surface appears to be the duration of the optimum climatic conditions favoring the processes of pedimentation. Nevertheless, local geological circumstances restrict or assist the areal development of the surface of planation. The presence of the *rock bench,* a restricted erosional feature, and the *pediment,* a more widespread surface, within the same climatic regime is proof of this. It must be observed, however, that the *pediment* does not occur in the humid regime whereas the *rock bench* is not climatically restricted. Climatic control seems the more eminent inasmuch as the differing climatic regimes contain similar geological ingredients.

Local controls, as presented herein, include rock type, rock structures, and structural activity. In many of the examples cited the erosion surfaces bevel heterogeneous rock types. Obviously, variations in areal extent of the *pediment* in homogeneous rocks cannot be explained on the basis of lithologic differences. On the other hand, variability of lithology often yields irregularity in the extent of planation. Gilluly noted (Ajo Region, Arizona)[18] that "the narrowing of pediments . . . coincides with upstream narrowing of the formations most favorable to pedimentation." Bryan and McCann[19] observed similar relationships along the Upper Rio Puerco, New Mexico, where broad planation has occurred in belts of soft shale whereas in sandstone the surfaces are more restricted. The influence of rock type in this respect is abundantly illustrated along the east flank of the Colorado Front Ranges, as described recently by the present writer[20]. Nevertheless, the broad arid and semiarid lands of the world are characteristically floored with beveled bedrock and are notably lacking in major relief differences. If it is a reasonable hypothesis, as believed by many workers, that these extensive surfaces of truncation result from pediment coalescence, then pedimentation processes are capable of indiscrimi-

[15] W. H. Bradley, "Pediments and Pedistals in Miniature," *Journal of Geomorphology,* III (1940): 244–255.

[16] McGee, *op. cit.,* p. 91.

[17] Bryan, *op. cit.,* p. 767.

[18] James Gilluly, "Physiography of the Ajo Region, Arizona," *Bulletin, Geological Society of America,* XLVIII (1937): 332.

[19] Kirk Bryan and Franklin T. McCann, "Successive Pediments and Terraces of the Upper Rio Puerco in New Mexico," *Journal of Geology,* XLIV (1936): 145–172.

[20] B. A. Tator, "Piedmont Interstream Surfaces of the Colorado Springs Region, Colorado," *Bulletin, Geological Society of America,* LXIII (1952): 266.

nate planation of heterogeneous lithology if uniform controls operate for sufficient time.

Rock structures, joint systems, schistosity, foliation, etc., may locally aid (or obstruct) the horizontal extension of the bedrock surface. For example, joint spacings tend to influence the texture of debris from a rock exposure, as was pointed out by Lawson[21], Bryan [22], and more recently by Gilluly[23]. Debris of a particular texture may be efficiently removed under existing runoff conditions whereas debris of another texture may tend to accumulate. The cloaking effect of such accumulations obstructs the weathering-retreat of escarpments, thereby retarding extension of the bedrock surface. Moreover, excessive debris accumulations must also have restrictive effects on extension of the truncation level by stream corrasion. Variations in areal extent of the pediment are often attributable to such controls. Nevertheless, regions containing diverse rock structures commonly are completely planate, indicating that long-continued pedimentation is eventually capable in this respect.

The influences of structural movement were hypothetically analyzed by Lawson[24], Davis[25], and others. In most discussion pertaining to this activity emphasis has been placed on the influence of a rising baselevel of alluviation in the enclosed desert basin. The association of pedimentation processes with rising baselevel has so colored geomorphic thought that many students accept the circumstance of wasting highlands supplying debris to adjacent enclosed desert basins as essential to rock planation. The fact of the matter is that the enclosed desert basin is a geologic rarity. Moreover, the majority of pediment localities listed herein are not of this category. Furthermore, even in most cases of centripetal drainage (interior) the broadly planate rock floors are only thinly veneered with alluvium. An outstanding example of the latter circumstance is found in the Gobi which has been described as essentially a rock desert thinly coated with water-borne detritus[26]. The greater portion of interior western Australia has similarly been described as a thinly alluviated rock plane[27]. Bryan[28] stated quite correctly that "It is not necessary . . . to suppose that every drainage system in an arid or desert country ends in an enclosed basin . . .," and further, ". . . that local baselevel may be stationary or slowly lowering from the beginning of the process." It is generally accepted that the vast rock deserts represent the ultimate stage of arid planation, as was suggested

[21] A. C. Lawson, "The Epigene Profiles of the Desert," *University of California Publication, Geology Bulletin*, IX (1915) : 23–48

[22] Kirk Bryan, "Erosion and Sedimentation in the Papago Country, Arizona," *United States Geological Survey*, Bulletin 730 (1922) : 19–90.

[23] Gilluly, *op. cit.*, p. 342.

[24] Lawson, *op. cit.*, pp. 23–48.

[25] W. M. Davis, "Rock Floors in Arid and Humid Climates," *Journal of Geology*, XXXVIII (1930), Pt. I: 1–27; Pt. II: 136–158.

[26] Berkey and Morris, *op. cit.*, p. 59.

[27] Jutson, *op. cit.*, p. 423.

[28] Bryan, "The Formation of Pediments," p. 769.

by Passarge[29]. An interim of long-continued structural stability would appear a necessity to achieve such final degradation. Davis[30] observed to this effect that "occurrence of widespread rock plains proves that at least the present cycle of arid erosion has been long continued without disturbance." Relative structural stability should promote the most widespread planation effects whereas structural instability should provide restrictive influences.

In regions from which detritus is being regularly removed at a rate equal to its replenishment by weathering and erosion, planation will take place under either structural stability, slow uplift, or slow subsidence. Slow uplift, at a rate which will allow the retreat of limiting escarpments by weathering and by the widespread horizontal shifting of corrasion loci, is favorable to pedimentation. Similarly, slow sinkage, at a rate which will allow leveling of the bedrock above the edge of a slowly rising alluvial accumulation, is also advantageous. The latter circumstance has been described in portions of the American Southwest[31]. Pedimentation, however, could not occur, or would be greatly restricted, with rapid uplift or subsidence of a region. Escarpment recession, either by weathering or lateral stream erosion, would be unable to keep pace with the accelerated incision of drainage lines occasioned by rapid uplift. Moreover, planation at one level for extended intervals would be prevented by confinement of the runoff loci in the ever-deepening channels. Rapid subsidence should promote alluvial flooding of the drainage lines, thus choking the runoff lines beyond capacity and insulating the bedrock against either weathering or stream corrasion.

Multiple pediment levels commonly occur along regional escarpments, each being restricted in areal extent by remnants of the next higher level of the sequence. A well developed series of this nature is present along the eastern flank of the Colorado Front Ranges. Wahlstrom[32] has suggested that this multiplicity results from alternating intervals of rest and uplift, planation occurring during the pauses. The present writer has offered an hypothesis of climatic fluctuation during slow but constant uplift to explain this sequence[33]. In the latter hypothecation planation is brought about by weathering-recession of valley sidewalls and shifting loci of stream corrasion under semiaridity; the intervals of dissection between the levels are brought about by runoff rejuvenation and channel confinement under slightly more humid conditions. Either of these two explanations may prove plausible. In any case, multiplicity of planation levels is evidence of restriction of pedimentation processes by some intermittently occurring control.

[29] S. Passarge, *Die Kalahari.* (Berlin, 1904). p. 195.

[30] W. M. Davis, "The Geographical Cycle in an Arid Climate," *Journal of Geology,* XIII (1905): 394.

[31] Lawson, *op. cit.,* pp. 23–48.

[32] E. E. Wahlstrom, "Cenozoic Physiographic History of the Front Range, Colorado," *Bulletin, Geological Society of America,* LVIII (1947): 551–572.

[33] Tator, *op. cit.,* p. 273.

Shape in Plan

Pediment shape is variable, the more resistant rock types providing restrictions and the weaker rocks allowing for broader development. If the planation processes are long-continued, however, shape irregularities may be eliminated and coalescence of adjacent pediments is likely to occur, providing the neighboring surfaces are at similar elevations. If the bedrock surface is developed in homogeneous rocks its plan shape should be quite regular, presenting an upslope narrowing to an apex and a downslope widening to a distal convexity. Gilluly[34] has expressed this shape expectability with the statement that "Any outward-sloping surface conforming to the mountain base must, of necessity, have this shape whatever its origin." This plan form, however, is not invariable and where diverse lithologies and rock structures exist irregularities are common.

Johnson[35] averred that the *fan-shape* must prevail if erosional development of the surface is by "an inclined stream relatively (but not rigidly) fixed in position at the point of issuance from the canyon mouth and shifting more and more widely below that point." He further claimed that field evidence reveals the existence of these *rock fans*. The most important factor controlling pediment shape is, according to Johnson, the undercutting of sidewalls by laterally swinging streams. Rich[36] also concluded that the *fan-shape* is common but for different reasons than those suggested by Johnson. Rich claimed that both *rock fan* and *pediment* are surfaces left behind as an escarpment retreats. These forms may be maintained by running water, but are not necessarily carved by this means. It is not the present intent to adjudge pediment origin on the basis of shape. Most described pediments are either highly irregular or approach in some degree a form which narrows upslope. The best expression of fan-like form is usually found in the apical portion.

Long-continued regional pedimentation under conditions of structural stability leads to a merging of the separate units of planation. On the other hand, structural or climatic interruption of the optimum conditions for pedimentation leads to a multiplicity of pediment levels. It is the present writer's opinion that the broad, nearly featureless, erosional rock deserts of the world are the product of pedimentation under long-continued climatic and structural stability.

Shape in Profile

The longitudinal profile of the pediment has been recognized by most students to be similar to the smoother segments of the stream profile, that is concave-upward. The predominance of this profile characteristic is shown in the included table.

[34] Gilluly, *op. cit.*, p. 332.

[35] Douglas Johnson, "Rock Planes of Arid Regions," *Geographical Review*, XXII (1932): 659.

[36] John L. Rich, "Origin and Evolution of Rock Fans and Pediments," *Bulletin, Geological Society of America*, XLVI (1935): 999–1024.

Lawson's[37] description of a convex-upward profile (*suballuvial bench*) was purely deductive, assuming a rising alluvial baselevel in an enclosed desert basin. It is not the purpose here to deny that such a profile may be produced under those circumstances. However, the *suballuvial bench,* a buried feature, will remain undetected unless later deep dissection reveals it. Davis[38] also described a convex-upward element on late stage degradational forms, *desert domes,* in the Mohave Desert in California. Johnson[39] suggested that the convexity of longitudinal profile of some erosion surfaces may be the result of "regrading" by streams. Two pediments of the Ajo Mountain region are described by Gilluly[40] as having convex-upward profiles in their headward portions. The latter worker states that "No lithologic boundaries correspond to the change in curvature, and they may be due to piracy along these streams affecting the stream volume." Gilluly clearly denies that the surfaces in question are exhumed examples of Lawson's *suballuvial bench.* The present writer has observed small headward convexities on erosion surfaces in the mouths of mountain canyons of the Colorado Front Ranges. This profile condition, however, is the exception rather than the rule. Field[41] recognized the possibility of upward convexity of the planation surface, closely following Lawson in this respect. He denied, however, that the concave-upward *pediment* and the convex-upward *suballuvial bench* are similar features. On the other hand, Rich[42] concluded that both the concave- and convex-upward profiles are expectable, the latter being a late stage characteristic found in headward portions of the erosion surface.

The longitudinal profile (concave) should not be assumed to be a smooth curve in all cases. It is rather, similar to the average stream profile, segmented, the smoother portions being developed across areas of homogeneous rock. Across heterogeneous rocks the profile is segmental, steeper on the more resistant and gentler on the less resistant types. Bryan[43] discovered that the longitudinal pediment profile is steeper opposite intercanyon areas than below the canyon mouths of the mountain front. Gilluly[44] found in addition that the surface gradients are steeper along smaller streams than along larger ones, noting that lithologic influence "exercises a marked control that commonly outweighs the factor of stream size. Rocks yielding coarse and resistant debris have steeper pediments than those yielding relatively finer and friable debris. The size of material yielded to the head-

[37] Lawson, *op. cit.,* pp. 23–48.

[38] W. M. Davis, "Granite Domes of the Mohave Desert, California," *San Diego Natural History Society Transactions,* VII (1933): 219–222.

[39] Douglas Johnson, "Rock Planes," p. 665.

[40] Gilluly, *op. cit.,* p. 333.

[41] Ross Field, "Stream Carved Slopes and Plains in Desert Mountains," *American Journal of Science,* 5th Series, XXIX (1935): 313–321.

[42] Rich, *op. cit.,* pp. 1022, 1024.

[43] Kirk Bryan, "The Papago Country, Arizona," *United States Geological Survey, Water Supply Paper* 499 (1925): 95.

[44] Gilluly, *op. cit.,* p. 332.

waters of the stream may also impose a steeper gradient than would be normal to a given formation . . . on friable rocks even small streams generally have pediments with low gradients . . . massive formations . . . large blocks . . . do not permit . . . such low gradients even along the larger streams." Sharp[45] enlarged somewhat on this point, observing that the longer, smoother profiles are developed on soft rocks whereas the shorter, steeper ones occur on more resistant rocks. Moreover, he avers that the shorter steeper profile is generally related to drier climatic conditions than the longer, more gentle one. Howard[46], on the other hand, could find no difference in gradient between shorter and longer distances to base-level on opposite sides of the Sacaton Mountains, Arizona. The latter author averred, however, that the gradient is determined by load-volume relationships and larger streams do not have as steep a gradient as do smaller ones[47].

The shape in transverse profile, particularly near the pediment head, may prove diagnostic as to origin processes of the surface. Four differing conditions have been observed in this respect; 1) essentially level, 2) sloping in one direction of the profile, 3) convex-upward (fan-shaped), and 4) concave-upward (scoop-shaped). The profile conditions observed by the various workers are cited in the included table. Most students agree that the pediment is essentially level in transverse profile in the distal portion (or at the most is gently undulating).

Johnson[48] and Howard[49] have been most emphatic that the convex-upward (fan-shaped) transverse profile is common to the apical portions of most pediments and is evidence favoring development by lateral planation. Johnson expressed this in his statement that "if the pediment is the product of lateral planation, and the mountain front retreats mainly through trimming of its frontal spurs as the shifting streams . . . impinge against them . . . should exhibit a series of relatively flat semi-cones or less than semi-cones. Each . . . a bedrock surface having the form of a typical fan, and apexing like the alluvial fan at the mouth of the canyon from which issued the sculpturing stream." Howard is also clear in this, stating that the transverse profiles of pediment embayments (apical portions) depend on the relative activities of main and tributary streams, a convex profile if widening is by main stream lateral corrasion action, a concave profile if the side streams have been most active in this respect. A combination form in this sense will be produced, that is a central convexity and marginal concavities, if both main and side streams are sufficiently active.

[45] R. P. Sharp, "Geomorphology of the Ruby-East Humboldt Range, Nevada," *Bulletin, Geological Society of America,* LI (1940) : 362.

[46] Howard, *op. cit.,* p. 139.

[47] A. D. Howard, "Pediment Passes and the Pediment Problem," Part II, *Journal of Geomorphology,* V (1942) : 115.

[48] Douglas Johnson, "Rock Fans of Arid Regions," *American Journal of Science,* 223 (1932) : 391–393.

[49] Howard, "Pediment Passes," 135.

Gilluly's[50] work in the Ajo region revealed that there all the pediments are concave (trough-shaped) in transverse profile save one which he recognized to be definitely fan-shaped (convex-upward). Moreover, he concluded that the concave condition indicates that lateral planation did not produce these surfaces, but rather they were developed by rill wash action. Bryan[51], on the other hand, recognized the convex (fan-shaped) cross profile to be an early pedimentation form, the concave (scoop-shaped) profile being a late stage form. Others who have held the cross profile shape to be significant include Field[52], who felt that the *suballuvial bench* should generally exhibit a transverse upward convexity, and Rich[53], who held the *rock fan* form to be, along with the *pediment,* the expectable features found along the bases of retreating escarpments in arid and semiarid regions.

Surface Features

Much has been written concerning the angle between the erosion surface and adjacent higher terrain. Field[54], for example, believes that this "knickpoint," as it has been called, is the natural result of juncture between the more gently sloping stream-cut pediment surface and the more steeply sloping rill-cut interstream slope. The sharpness of this angle was related by Bryan[55] to the character of the rocks and the climate. According to the latter, widely spaced joints yield the steepest slopes thus increasing the angularity between erosion surface and limiting escarpment. Moreover, he believed the "knick" to be sharper under the more arid influences. The fundamental cause for the presence of this angle, as presented by Bryan, is more efficient stream transportation on the pediment surface as compared with lesser efficiency in this respect on the adjacent sidewall areas. Gilluly[56] suggests, in somewhat the same light, that the angular junction is entirely expectable inasmuch as the steeper mountain slopes are controlled by gravity in contrast to the more gentle pediment surface which is controlled by rill wash. The latter view is similar to that held by Lawson[57] and Davis[58], namely that the pediment is controlled in gradient by the minimum slope on which the supplied debris can be transported, the mountain slopes, on the other hand, being at the angle of repose for larger blocks under the influence of gravity. Waibel[59] recognized the "knick" to

[50] Gilluly, *op. cit.*, p. 341.
[51] Bryan, "Formation of Pediments," p. 772.
[52] Field, *op. cit.*, p. 321.
[53] Rich, *op. cit.*, p. 1024.
[54] Field, *op. cit.*, p. 317.
[55] Kirk Bryan, "Processes of Formation of Pediments at Granite Gap, New Mexico," *Zeitschrift fur Geomorphologie*, Bd. IX (1935–36): 125–136.
[56] Gilluly, *op. cit.*, p. 346.
[57] Lawson, *op. cit.*, p. 30.
[58] Davis, "Rock Floors," p. 153.
[59] Leo Waibel, "Die Inselberglandschaften von Arizona und Sonora," *Zeitschrift der Gesellschaft für Erdkunde*, Berlin, Jubilaums-Sonderband (1928): 64–85.

be evidence that rill and surface wash are the important pedimentation processes. Johnson[60], by contrast, strongly favored the lateral impingement of streams as the major cause for presence of the "knick". Howard[61] for the most part follows the last writer in this belief but also describes marginal slopes controlled by weathering. In the greater number of works describing pediments, however, the "knick" angle is not adequately treated. It is certainly a reasonable expectation that careful analysis of this surface feature should aid in interpretation of the pedimentation processes which have prevailed in differing circumstances.

In some of the published pediment descriptions the existence of protuberances above the erosion surface is noted. Bornhardt[62] termed these residual hills *inselbergs*. Passarge[63] also noted their occurrence in the desert erosion plains of South Africa. Holmes and Wray[64] recognized the feature, referring to the "inselberg landscape" of the Mozambique region, noting the strikingly abrupt rise of these residual hills from the erosion level, as well as their linear arrangement. The latter authors attributed the origin of these landforms to differential weathering of dome-like igneous intrusions. Bryan[65] interpreted the inselbergs in the Papago Country (Arizona) to be the residuals of former inter-stream ridges which had been cut through by slope recession from both sides thus leaving some portions intact but isolated. He observed that the inselbergs maintained slopes as steep as those of the adjacent mountain escarpments, growing gradually smaller in size until eventually completely consumed by the processes of slope retreat. Johnson[66], on the other hand, pointed to the sharp angle (knick) between pediment and inselberg as an indication that lateral corrasion and not weathering-retreat is the cause of destruction of the feature, thus emphasizing his hypothesis that the dominant pedimentation process is lateral planation.

Few pediment surfaces are entirely undissected, most exhibiting post-pedimentation stream trenching. Gilluly[67] found the Ajo region surfaces, particularly in their upslope portions, to be incised by a fine textured dendritic channel system. The rock surface of the erosion plane in Mongolia is, according to Berkey and Morris[68], cut by a network of shallow rill courses, believed to be the agency of pedimentation. Johnson[69] also noted braided stream channel patterns on certain of the surfaces and claimed these shifting channels to be the means of lateral cor-

[60] Johnson, "Rock Planes," pp. 659–660.
[61] Howard, "Pediment Passes," p. 30.
[62] W. Bornhardt, *Deutsch-Ost-Afrika-Geologie*, Bd. VII (1900). pp. 30, 37.
[63] S. Passarge, "Rumpfflache und Inselberge (Kordofan-type)," *Zeitschrift der Deutsches Geologie Gesellschaft*, LVI (1904) : 193.
[64] Holmes and Wray, *op. cit.*, pp. 147–148.
[65] Bryan, *Water Supply Paper 499*, p. 96.
[66] Johnson, "Rock Fans," p. 391.
[67] Gilluly, *op. cit.*, p. 329.
[68] Berkey and Morris, *op. cit.*, p. 330.
[69] Johnson, "Rock Planes," p. 660.

rasion activity. In the Granite Gap surfaces, as described by Bryan[70], the bedrock is in places marked by irregular rill systems which suggest pedimentation by weathering and rill action, a belief which is strengthened by numerous ephemeral channels across much of the pediment surface. Davis[71] observed similarly that the *granite domes,* erosion surfaces of the Mohave region, are faintly channeled by the enmeshed flow-lines of sheetfloods. He concluded from this evidence that the convex-upward bedrock surface is produced by "rock-floor robbing" of the weathered material by sheetflood action.

In a recent writing the present author[72] described radiating systems of old stream lines in the surfaces of the pediment alluvium along the east flank of the Colorado Front Ranges. These are for the most part restricted to the surface alluvium and do not appear to be related to the underlying bedrock surface. Nevertheless, the otherwise comparatively smooth planation surface beneath the alluvium is dissected in many places by old stream channels which extend from a few inches to as much as 15 feet below the average bedrock level. These have been associated by the author with vertical scour action, the shift in loci of which was largely responsible for development of the rock surface.

Condition of Alluviation

The alluvial cover on pediment surfaces has been described as ranging from zero on some to more than 200 feet on others. In the Sonoran region,[73] for example, this cover is limited in areal extent and thickness, much of the surface being bedrock, in places lightly veneered with detritus usually but a yard or two in thickness. Bryan[74] stated that 18 inches to five feet of alluvium is normal for the pediments of the Papago country, and there are no greater thicknesses than 6 inches on the rock floors at Granite Gap.[75] Blackwelder's[76] discussion of the Basin and Range region mentions the presence of former pediments now covered with thick alluvial fans (50 to 200 feet). Maximum thickness observed by Gilluly[77] in the Ajo region was 15 feet, although the bedrock surface is "in much larger part of bare rock." Surfaces associated with the Colorado Rockies have been described as veneered with alluvium ranging from 10 to 20 feet,[78] 25 to 50 feet,[79] to greater than 100 feet[80]

[70] Bryan, "Granite Gap," pp. 125–136.
[71] Davis, "Granite Domes," pp. 219–222.
[72] Tator, *op. cit.*, p. 260.
[73] McGee, *op. cit.*, pp. 91, 102–103.
[74] Bryan, "Erosion and Sedimentation in the Papago Country," p. 59.
[75] Bryan, "Granite Gap," pp. 125–136.
[76] E. Blackwelder, "Desert Plains," *Journal of Geology,* XXXIX (1931): 139.
[77] Gilluly, *op. cit.*, p. 329.
[78] N. Fenneman, "Geology of the Boulder District, Colorado," *United States Geological Survey,* Bulletin 265 (1905): 14.
[79] W. T. Lee, "The Origin of the Debris-Covered Mesas of Boulder, Colorado," *Journal of Geology,* VIII (1900): 504.
[80] Tator, *op. cit.*, p. 261.

in some localities. Additional references to alluvial thicknesses are listed in the accompanying table.

Pediment alluvium is usually poorly sorted and, at best, rudely stratified, in general having the character of a torrential deposit. In most occurrences this material becomes more definitely stratified and develops better sorting in the downslope direction. The coarser and more angular fragments are found in headward portions, there being a progressive decrease in size and better rounding of the fragments down the slope. Exceptions to this general character, however, have been noted. Bryan,[81] for example, found the debris on the surfaces at Granite Gap to consist of fine sand and small chip sizes. Berkey and Morris[82] described the Gobi piedmont slopes as thinly and evenly strewn with small chips of native rock derived from the weathering of the underlying bedrock.

Sharp[83] reached conclusions which, in the present writer's opinion, may lead to an understanding of the continuum of processes which yields pedimentation. He found that pediments formed by weathering are largely bare whereas those formed by lateral planation are generally uniformly alluviated. There certainly exists a relationship between alluviation characteristics of the erosion surface and processes responsible for its development. An analysis of such relationships is needed, including consideration of the particular planation processes produced under different climatic controls.

In the majority of writings the pediment alluvium is described as wedge-shaped, thickening downslope and thinning upslope. However, there are also examples of thinning in both slope directions from a maximum section (Bradley,[84] Howard,[85] Tator[86]). Analysis of the literature thus shows the existence of three general alluviation conditions: 1) alluvium absent or thin and discontinuous; 2) alluvium wedge-like, thickening basinward; and 3) alluvium lense-shaped, thinning both basinward and toward the apex from a maximum section. The first of these conditions has been accepted by some as the expected result of pedimentation by weathering-retreat of escarpments aided by rill and rain wash (Berkey and Morris,[87] Bryan,[88] and Sharp[89]). Others have suggested post-sedimentation stripping of a former alluvial cover to explain this phenomenon (Lawson,[90] Paige,[91] Sharp[92]).

[81] Bryan, "Granite Gap," pp. 125–136.

[82] Berkey and Morris, *op. cit.*, p. 330.

[83] Sharp, *op. cit.*, p. 364.

[84] W. H. Bradley, "Geomorphology of the North Flank of the Uinta Mountains," *United States Geological Survey, Professional Paper 185-I* (1936): pp. 172.

[85] Howard, "Pediment Passes," p. 101.

[86] Tator, *op. cit.*, pp. 261–262.

[87] Berkey and Morris, *op. cit.*, p. 331.

[88] Bryan, "Formation of Pediments," p. 773.

[89] Sharp, *op. cit.*, p. 364.

[90] Lawson, *op. cit.*, p. 37.

[91] Sidney Paige, "Rock-cut Surfaces in the Desert Ranges," *Journal of Geology,* XX (1912): 442–450.

The second condition may be explained as the expectable type in an enclosed basin with the alluvium gradually encroaching mountainward over the erosion surface (Lawson[93]). The third condition has not yet been adequately explained, although Bradley[94] has suggested that climatic change to slightly more arid may produce a thickening of the alluvial section just below the steepest portion of the surface profile. The latter opinion has also been expressed by the present writer.[95]

The thickness of alluvium on pediment surfaces often averages about the depth of effective stream scour. Howard[96] was apparently aware of this when he suggested that the term *pediment* be restricted in usage to refer to either the bare rock erosion surface or the bedrock surface alluviated to the "depth of stream scour during flood". Alluvial thicknesses are of this magnitude in most of the pediment levels along the east flank of the Colorado Front Ranges.[97] Erosion surfaces produced by stream action must remain within the scope of stream corrasion during their development. Hence, unless post-pedimentation processes have stripped away, or added to, the alluvial cover, such surfaces should be alluviated to the depth of stream scour. An excessive alluvial section, under any consideration, must be the result of post-pedimentation processes, perhaps an indication of climatic change. A lack of, or discontinuous occurrence of, alluvial section may indicate either post-pedimentation stripping or development of the surface by agencies other than concentrated running water. As mentioned earlier, the continuum of climatic controls and processes engendered by such controls needs further analysis before conclusions can be reached on this score.

APPENDIX.

Summary of 43 pertinent works.

ARIZONA

Tolman. Locality, Tucson area, 1909. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 50–300 feet per mile. Transverse profile: not stated. Conditions of alluviation: thins mountainward, thickens basinward. Terminology: rock slope. Suggested processes of origin: concentrated runoff. Annual rainfall: 10 inches. Pertinent data: weathering, water corrasion, deflation.

Bryan. Locality, Papago country, 1925. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 50–200 feet per mile. Transverse profile: concave upward, trough-shaped. Condition of alluviation: 1–5 feet discontinuous. Terminology: concealed pediment, rock pediment. Suggested processes of origin: slope retreat, unconcentrated runoff. Annual rainfall: 10 inches. Pertinent data: combination slope retreat (weathering) aided by rill wash and unconcentrated runoff, some lateral planation.

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[92] Sharp, *op. cit.*, p. 365.
[93] Lawson, *op. cit.*, p. 30.
[94] Bradley, *op. cit.*, p. 178.
[95] Tator, *op. cit.*, p. 270.
[96] Howard, "Pediment Passes," p. 8.
[97] Tator, *op. cit.*, p. 273.

Childs. Locality, Little Colorado River, 1948. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: plateau area. Longitudinal profile: concave upward. Degree of slope, 20–30 feet per mile. Transverse profile: essentially level. Condition of alluviation: depth of flood scour, maximum 25 feet. Terminology: pediment, peripediment. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: closely follows Johnson and Howard (See below)

Waibel. Locality, Sonoran area, 1928. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 50–300 feet per mile. Transverse profile: essentially level. Condition of alluviation: thin or absent. Terminology: pediment. Suggested processes of origin: rill and surface wash. Annual rainfall: 10 inches. Pertinent data: alluvial cover post-pedimentation.

Gilluly. Locality, Ajo Region, 1937. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: Two surfaces convex upward, most concave upward. Degree of slope: 70–300 feet per mile. Transverse profile: one convex upward, most trough-shaped. Condition of alluviation: thin to discontinuous. Terminology: rock fan pediment. Suggested processes of origin: rill wash and weathering. Annual rainfall: 10 inches. Pertinent data: general relationship between lithology and pediment extent. Some lateral planation in addition to rill wash and weathering.

COLORADO

Lee. Locality: Boulder area, 1900. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 325 feet per mile. Transverse profile: essentially level or sloping (1) direction. Condition of alluviation: relatively uniform, 25 feet to 50 feet. Terminology: mesa, mesa-terrace. Suggested processes of origin: lateral planation. Annual rainfall: 15–20 inches. Pertinent data: associated with mountain-borne drainage. Truncate dipping sediments of foothills belt.

Fenneman. Locality: Boulder area, 1905. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 1° to 10°. Transverse profile: sloping in one direction. Condition of alluviation: relatively uniform 10 to 20 feet. Terminology: mesa. Suggested processes of origin: lateral planation. Annual rainfall: 15–20 inches. Pertinent data: cut mostly across tilted shale beds.

Tator. Locality: Colorado Springs area, 1952. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: few small convex upward, most concave upward. Degree of slope: 50–500 feet per mile. Transverse profile: some essentially level, some sloping one direction, some convex upward. Condition of alluviation: some bare rock, most thin mountainward and downslope, average cover 15–20 feet. Terminology: pediment, piedmont interstream flat. Suggested processes of origin: slope retreat by weathering, vertical corrasion by shifting runoff channels. Annual rainfall: 15 inches. Pertinent data: most extensive surfaces in shales. Some truncate dipping sediments of heterogeneous nature with no apparent regard for lithology.

Glock. Locality: Book Cliffs area, 1932. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: base of plateau escarpment. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: thin veneer (discontinuous). Terminology: pediment. Suggested processes of origin: weathering recession and basal sapping. Annual rainfall: 8 inches. Pertinent data: mostly cut in shales at base of plateau-like escarpment.

Powers. Locality: Upper Arkansas Valley, 1935. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: intermontane. Longitudinal profile: smoothly sloping. Degree of slope: 22–350 feet per mile. Transverse profile: not stated. Condition of alluviation: thin veneer. Terminology: pediment terrace. Suggested processes of origin: planation. Annual rainfall: 15–20 inches. Pertinent data: alluviated rock-cut pediments in sediments at base of rimming mountains.

NEW MEXICO

Denny. Locality: San Acacia area, 1941. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 250 feet per mile. Transverse profile: some fan-shaped, most essentially level. Condition of alluviation: gravel-capped, 1–35 feet. Terminology: rock fan, pediment. Suggested processes of origin: escarpment retreat, limited lateral planation. Annual rainfall: 10 inches. Pertinent data: headward cutting of closely spaced drainage lines.

Ray and Smith. Locality: Moreno Valley, 1941. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 185–460 feet per mile. Transverse profile: essentially level. Condition of alluviation: gravel-capped, thin. Terminology: pediment. Suggested processes of origin: escarpment retreat, limited lateral planation. Annual rainfall: 10 inches. Pertinent data: headward cutting of closely spaced drainage lines.

Bryan. Locality: Granite Gap, 1936. Drainage: exterior. Lithologic environment: mostly granite. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: gentle. Transverse profile: concave upward (trough-shaped). Condition of alluviation: thin, discontinuous. Terminology: pediment. Suggested processes of origin: rill action. Annual rainfall: 10 inches. Pertinent data: unconcentrated rill and rain wash.

Howard. Locality: Sacaton Mountains, 1942. Drainage: exterior. Lithologic environment: heterogeneous, mostly granite. Physiographic environment: piedmont. Longitudinal profile: concave upward, convex upward (head). Degree of slope: 200–250 feet per mile. Transverse profile: concave upward, convex upward. Condition of alluviation: thickness equal to depth of stream scour. Terminology: pediment, pediplane, peripediment. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: lateral planation by main and tributary streams. Concave upward transverse profile due to corrasion of valley side by tributary streams.

Johnson. Locality: Sacaton Mountains, 1931. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level, convex upward. Condition of alluviation: thin to absent. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: Fan-shaped surfaces in headward portions at canyon mouths (rock fan).

Johnson. Locality: Ortiz Mountains, 1931. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level, convex upward. Condition of alluviation: thin, thickening downslope. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: dominant lateral planation, rill and rain wash, minor weathering. Fan-shaped surfaces in headward portions.

Johnson. Locality: Sandia Mountains, 1931. Drainage: exterior. Lithologic environment: heterogeneous sediments. Physiographic environment: piedmont. Longitudinal pro-

file: concave upward. Degree of slope: not stated. Transverse profile: essentially level, convex upward. Condition of alluviation: thin, thickening downslope. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: small surfaces in headward portion fan-shaped.

Johnson. Locality: Sante Fe Mountains, 1931. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level, convex upward. Condition of alluviation: thin, thickening downslope. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: small surfaces in headward portion fan-shaped.

Johnson. Locality: Cerrillos Hills, 1931. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level, convex upward. Condition of alluviation: thin, thickening downslope. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: small surfaces in headward portion fan-shaped.

Paige. Locality: Silver City area, 1912. Drainage: interior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: convex upward. Condition of alluviation: thin, thickening downslope. Terminology. rock-cut bench, rock-cut plain. Suggested processes of origin: lateral planation. Annual rainfall: 5 inches. Pertinent data: lateral planation aided by interstream degradation. Alluvium stripped from many surfaces because of faulting-uplift.

Ogilvie. Locality: Ortiz Mountains, 1905. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: encircling mountain mass. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: convex upward. Condition of alluviation: thin, irregular. Terminology: conoplain. Suggested processes of origin: stream corrasion. Annual rainfall: 10 inches. Pertinent data: conoplain—partly cut, partly built feature. Defined as encircling a laccolithic mountain mass.

Bryan and McCann. Locality: Upper Rio Puerco area, 1936. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: thin, thickening basinward. Average to depth of stream scour. Terminology: pediment. Suggested processes of origin: lateral planation, rill and rain wash. Annual rainfall: 10 inches. Pertinent data: most extensive pediments in soft shales. Lateral planation early, rill and rain wash later.

WYOMING

Mackin. Locality: Bit Horn Basin, 1937. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 65–90 feet per mile. Transverse profile: essentially level. Condition of alluviation: uniform 14–18 feet. Terminology: stream-cut bench or terrace, partial pediment. Suggested process of origin: lateral planation. Annual rainfall: 10–20 inches. Pertinent data: lateral corrasion by major through-flowing streams.

Bradley. Locality: North flank Uinta Mts., 1936. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: slightly concave upward. Degree of slope: 55–400 feet per mile. Transverse profile

essentially level. Condition of alluviation: thinning downslope, maximum 140 feet. Terminology: pediment. Suggested processes of origin: lateral planation. Annual rainfall: 10–20 inches. Pertinent data: thicker alluvium deposited post-pedimentation.

MISCELLANEOUS AREAS.

Weed. Locality: Little Belt Mts., Montana, 1899. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 275–450 feet per mile. Transverse profile: not stated. Condition of alluviation: not stated. Terminology: pediment. Suggested processes of origin: not stated. Annual rainfall: 10–20 inches. Pertinent data: no detailed description of surfaces or processes.

Sharp. Locality: Ruby-East Humboldt, Nevada, 1940. Drainage: interior; exterior. Lithologic environment: hard rocks; soft rocks. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 400–500 feet per mile; 75–350 feet per mile. Transverse profile: concave upward; essentially level. Condition of alluviation: covered with alluvium; uniform veneer to bare. Terminology: pediment. Suggested processes of origin: weathering and lateral planation; lateral planation. Annual rainfall: 10–20 inches. Pertinent data: graded to a rising baselevel. Weathering, rill and rain wash most effective in low mountains, hard rocks, along ephemeral streams. Graded to a lowering baselevel. Lateral planation, soft rocks, permanent flow.

Gilbert. Locality: Henry Mountains, Utah, 1880. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: not stated. Condition of alluviation: alluviated to depth of scour. Terminology: hills of planation. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: first description of stream-cut desert surfaces in the United States.

McGee. Locality: Sonoran area (Southwestern U. S. and Northern Mexico), 1897. Drainage: exterior. Lithologic environment: heterogeneous, much granite. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 20–300 feet per mile; average 65 feet per mile. Transverse profile: essentially level. Condition of alluviation: lightly veneered, 0–18 feet. Terminology: granite pediment, baselevel plain. Suggested processes of origin: sheetflood erosion. Annual rainfall: 10 inches. Pertinent data: sheetflood corrasion—some lateral cutting by sheetfloods.

King. Locality: Glass Mountains, Texas, 1930. Drainage: exterior. Lithologic environment: heterogeneous, much limestone. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: 75–300 feet per mile. Transverse profile: some convex upward, essentially level. Condition of alluviation: thickly mantled, 30–100 feet. Terminology: pediment. Suggested processes of origin: lateral planation. Annual rainfall: 9–17 inches. Pertinent data: thick alluvium largely post-pedimentation.

Davis. Locality: Mohave Desert, California, 1933. Drainage: interior. Lithologic environment: largely granite. Physiographic environment: piedmont. Longitudinal profile: convex upward at head to concave upward downslope. Degree of slope: 450 feet per mile at head. Transverse profile: not stated, assumed convex upward. Condition of alluviation: thin to bare upslope, thickening downslope. Terminology: granite dome, desert dome. Suggested processes of origin: sheetflood actions and weathering. Annual rainfall: 10 inches. Pertinent data: sheetfloods remove weathering material from upper slopes. Late stage uniform weathering with retreat of slopes.

Frye and Smith. Locality: Cimarron Valley, Kansas, 1942. Drainage: exterior. Litho-

logic environment: soft rocks. Physiographic environment: plains area. Longitudinal profile: concave upward. Degree of slope: gentle. Transverse profile: not stated. Condition of alluviation: thin veneer in transit. Terminology: valley slope. Suggested processes of origin: not stated. Annual rainfall: 18 inches. Pertinent data: graded valley sidewalls in flat land areas. Suggested similar to pediment in process of formation.

Mortensen. Locality: Northern Chilean Desert, South America, 1929. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: thin to thick. Terminology: inselberg landscape. Suggested processes of origin: surface and rill wash. Annual rainfall: 10–20 inches. Pertinent data: surface and rill wash. Efficacy of lateral planation not determined.

Berkey and Morris. Locality: Gobi Desert, Mongolia, 1927. Drainage: interior. Lithologic environment: heterogeneous. Physiographic environment: piedmont and desert basin. Longitudinal profile: concave upward. Degree of slope: 10° and less. Transverse profile: not stated. Condition of alluviation: thin to absent. Terminology: terrace, bench, pediment. Suggested processes of origin: rill corrasion. Annual rainfall: 8–10 inches. Pertinent data: weathering and rill action. Corrasion by closely spaced rill network.

Jutson. Locality: West Australian Desert, 1917. Drainage: interior. Lithologic environment: heterogeneous. Physiographic environment: plateau area. Longitudinal profile: sloping. Degree of slope: not stated. Transverse profile: essentially level to gently undulatory. Condition of alluviation: thin to absent. Terminology: not stated. Suggested processes of origin: weathering, rain action, sapping, wind erosion. Annual rainfall: 10 inches. Pertinent data: broadly truncated tracts of plateau-like character produced by processes of desert erosion (wind and water).

Johnson. Locality: Atlas Mountains, Algeria, 1931. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: essentially level, headward portions convex upward. Condition of alluviation: thin, thickening downslope. Terminology: piedmont erosion plane. Suggested processes of origin: lateral planation. Annual rainfall: 10 inches. Pertinent data: observed, but apparently not studied in detail.

Falconer. Locality: Northern Nigeria, 1911. Drainage: exterior. Lithologic environment: granites, gneisses. Physiographic environment: plateau area. Longitudinal profile: gently sloping. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: relatively thin and irregular. Terminology: base-levelled plain. Suggested processes of origin: weathering and erosion. Annual rainfall: 10–20 inches. Pertinent data: deeply weathered rock surfaces. Water and wind action periodically remove detritus. Variations in rock resistance produce inselbergs.

Stheeman. Locality: Southwestern Uganda, 1932. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward. Degree of slope: not stated. Transverse profile: apparently level. Condition of alluviation: thin. Terminology: none. Suggested processes of origin: weathering, flood sheets, and creep. Annual rainfall: 40–60 inches. Pertinent data: no detailed description of processes. Apparently similar to suggestions of Holmes and Wray below.

Holmes and Wray. Locality: Mozambique, 1913. Drainage, exterior. Lithologic environment: heterogeneous; granites, gneisses. Physiographic environment: piedmont plateau.

Longitudinal profile: sloping. Degree of slope: not stated. Transverse profile: apparently level. Condition of alluviation: alluviated but thickness not stated. Terminology: inselberg landscape. Suggested processes of origin: weathering and erosion. Annual rainfall: 40–60 inches, dry season. Pertinent data: alternate episodes of weathering and erosion related to intervals of subsidence and elevation. Weathering joint controlled.

Bornhardt. Locality: (Dutch) East Africa, 1900. Drainage: exterior. Lithologic environment: heterogeneous; granites, gneisses. Physiographic environment: plateau area. Longitudinal profile: sloping. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: alluviated but thickness not stated. Terminology: inselberg landscape. Suggested processes of origin: weathering and erosion. Annual rainfall: 20–60 inches. Pertinent data: apparently similar to Mozambique area.

Passarge. Locality: Kalahari Desert, 1904. Drainage: interior. Lithologic environment: heterogeneous. Physiographic environment: plateau basin area. Longitudinal profile: essentially flat to slightly sloping. Degree of slope: not stated. Transverse profile: essentially level. Condition of alluviation: thin, discontinuous. Terminology: none. Suggested processes of origin: wind and water erosion, peneplanation. Annual rainfall: 5–15 inches. Pertinent data: water work early—wind later. Old age desert surface.

King, L. C. Locality: South African area, 1942. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: plateau. Longitudinal profile: not stated. Degree of slope: not stated. Transverse profile: not stated. Condition of alluviation: alluviated, but thickness not stated. Terminology: rock pediment. Suggested processes of origin: weathering retreat of escarpments. Annual rainfall: 10–20 inches. Pertinent data: minimizes stream corrasion Some rill action

Collie. Locality: British East Africa, 1912. Drainage: exterior. Lithologic environment: gneisses. Physiographic environment: plateau. Longitudinal profile: concave upward. Degree of slope: 15–100 feet per mile, average 20 feet per mile. Transverse profile: essentially level. Condition of alluviation: thick alluvial and residual cover. Terminology: plateau. Suggested processes of origin: sheetflood erosion. Annual rainfall: 20–40 inches. Pertinent data: peneplanation by sheetfloods and wind.

HYPOTHETICAL WORKS

Lawson. Date: 1915. Drainage: interior. Lithologic environment: hypothetical environments. Physiographic environment: piedmont basins. Longitudinal profile: convex upward, concavo-convex. Degree of slope: not stated. Transverse profile: somewhat undulatory, essentially level. Condition of alluviation: bare to thin, thickening basinward. Terminology: suballuvial bench, subaerial bench. Suggested processes of origin: mechanical disintegration, gravity and rain wash, wind transportation. Annual rainfall: scanty. Pertinent data: hard rock slopes shedding large fragments are steep; those shedding small fragments are gentle. Persistent tendency to oversteepen at head giving an upward concavity. Late stage removal of alluvial cover may expose suballuvial bench.

Rich. Date: 1935. Drainage: exterior. Lithologic environment: hypothetical environments. Physiographic environment: piedmont basins. Longitudinal profile: concave upward, convex upward (head). Degree of slope: 50–300 feet per mile. Transverse profile: concave upward, convex upward (head). Condition of alluviation: thin, thickening basinward. Terminology: rock fan, pediment. Suggested processes of origin: weathering and unconcentrated sheetwash. Annual rainfall: scanty. Pertinent data: rock fans and pediments develop along wasting retreating escarpments. Lateral corrasion by streams not necessary. Repeated shifting of streams leaves gravel-protected rock surfaces, rock fan, and pediment.

Blackwelder. Date: 1931. Drainage: interior. Lithologic environment: hypothetical environments. Physiographic environment: piedmont basins. Longitudinal profile: slightly concave upward. Degree of slope: 45–675 feet per mile, average 230 feet per mile. Transverse profile: essentially level. Condition of alluviation: thin veneer, 50–200 feet on some. Terminology: fan-topped pediment, pediment. Suggested processes of origin: lateral planation aided by subaerial decay. Annual rainfall: scanty. Pertinent data: completion of regional pedimentation requires structural stability. Fan-topped pediments result from climatic or other factors.

Keyes. Date: 1908. Drainage: interior. Lithologic environment: heterogeneous. Physiographic environment: piedmont basins. Longitudinal profile: concave upward. Degree of slope: 200–300 feet per mile. Transverse profile: assumed essentially level. Condition of alluviation: thin veneer 12 feet. Terminology: bolson plains. Suggested processes of origin: use of "beveled" suggests planation. Annual rainfall: 10 inches. Pertinent data: no specific reference to description of processes or origin.

Davis. Date: 1930. Drainage: exterior, interior. Lithologic environment: heterogeneous. Physiographic environment: piedmont basins. Longitudinal profile: concave upward. Degree of slope: 275–375 feet per mile. Transverse profile: not stated. Condition of alluviation: thin, discontinuous. Terminology: piedmont pediment, rock pediment. Suggested processes of origin: lateral planation. Annual rainfall: scanty. Pertinent data: weathering and sheetflood action. Rock floor robbing by sheetfloods. Lateral planation.

Field. Date: 1935. Drainage: exterior, interior. Lithologic environment: hypothetical environments. Physiographic environment: piedmont basins. Longitudinal profile: concave upward, concavo-convex. Degree of slope: not stated. Transverse profile: essentially level to convex upward. Condition of alluviation: thin, thickening basinward. Terminology: pediment, suballuvial bench, rock plain. Suggested processes of origin: graded streams at canyon mouths. Annual rainfall: scanty. Pertinent data: work of graded streams issuing from mountain canyons rather than rills or sheetfloods. Doubtful of formation of "rock fans."

Johnson. Date: 1932. Drainage: exterior. Lithologic environment: heterogeneous. Physiographic environment: piedmont. Longitudinal profile: concave upward, convex upward (head). Degree of slope: 50–200 feet per mile. Transverse profile: essentially plane convex upward (head). Condition of alluviation: thin, thickening downslope. Terminology: rock fan, pediment. Suggested processes of origin: lateral planation. Annual rainfall: scanty. Pertinent data: fan-shaped "rock fan" at canyon mouth. Regrading can result in a convexity of the rock surface. Lateral planation is dominant.

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RICHARD ELWOOD DODGE, 1868–1952

S. S. VISHER

Richard Elwood Dodge contributed greatly to the Association of American Geographers. He was a member of the council for 15 years and editor of the *Annals* from its inception in 1911 to 1923, except during 1915. In that year, he was the Association's president. He served as secretary for five years after he had been president. In addition he contributed much counsel as a member of various committees. No other person has rendered the Association such diversified and prolonged service.

As a young man Professor Dodge made notable geologic field studies, and was starred as a distinguished geologist in the first edition of *American Men of Science* (starring done in 1903). His interest shifted from geology to geography, however, soon after he went to Teachers College, Columbia University, in 1895. There, he was professor of geography from 1897 to 1916. In 1897 he established the *Journal of School Geography* (later the *Journal of Geography*) and edited it for thirteen years. His publications include two series of elementary geography texts, co-authorship of a volume on the teaching of geography, and of two college texts. For his notable contributions to educational geography, he was awarded the National Council of Geography Teachers' Distinguished Service to Geography Award in 1946. A prize honoring him is awarded periodically by that Council to an author of an article published in the Journal during the preceding five years.

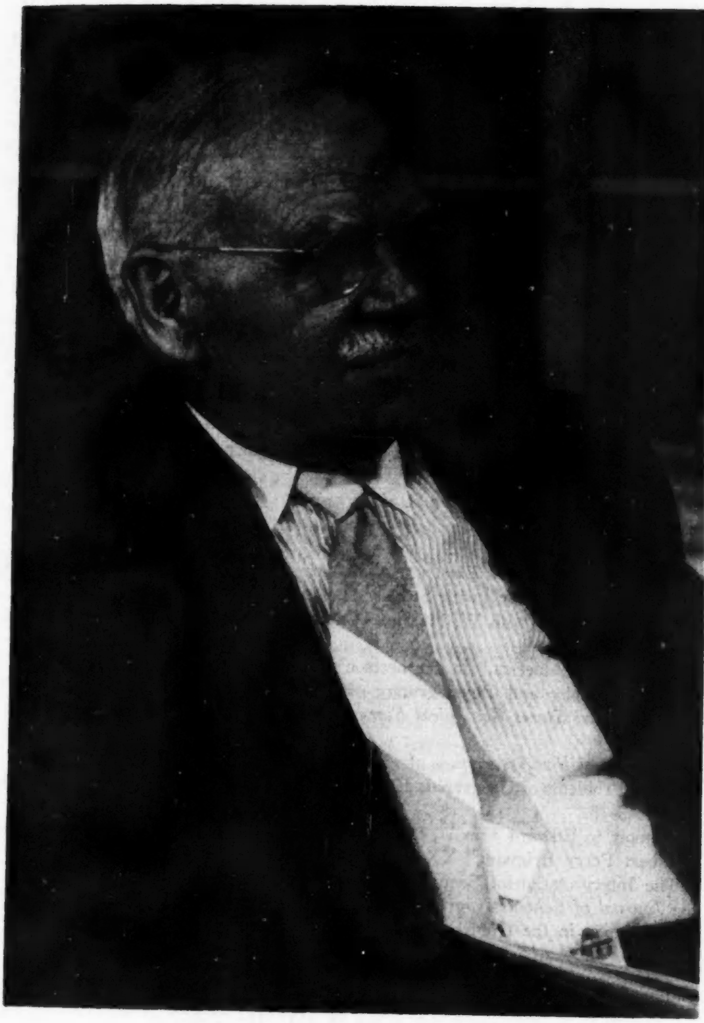
Professor Dodge was born near Wenham, Massachusetts on March 30, 1868, on a farm that for seven consecutive generations had yielded a Richard Dodge. He worked on that farm from boyhood to early manhood, graduated from the nearby Salem High School, and from Harvard in 1890. He received the M.A. degree from Harvard in 1894. He became much interested in geology as a result of a course in his junior year under the inspiring Nathaniel Southgate Shaler. He was Professor Shaler's assistant in that course during 1891–1894. In 1894 he was appointed instructor in geology. He was assistant to C. Willard Hayes of the U. S. Geological Survey for the summers of 1894 and 1895 in Alabama, Georgia, and Tennessee.

Graduate study with William Morris Davis increased his interest in physiography and proved invaluable in his training in many respects. He has said, "It was from Professor Davis that I gained whatever ability I possess in accurate thinking and in effective logical exposition." Physiography was Professor Dodge's dominant interest for some years until at Teachers College he turned to geography "because of the demands of the position."

During twenty one years at Teachers College, in addition to teaching and writing, Dodge was active in administration in the college and in the New York Academy of Science, and in editorial work, first of the *Journal of School Geography*

and later of the *Journal of Geography* and of the *Annals*. He edited a geographic journal during twenty-five of the first fifty-five years of his life.

Professor and Mrs. Dodge were married in 1896 and reared a daughter and two



RICHARD ELWOOD DODGE

sons, one of whom was the first son of a member of the Association of American Geographers to be elected thereto.

Professor Dodge retired from Teachers College in 1916 when he was 48. The relative freedom associated with retirement facilitated his time-consuming services to the Association of American Geographers during the next several years. He commenced administrative work with the extension service of the Connecticut State College (now the University of Connecticut) in 1918, and similar work in the college in 1920. Gradually he turned again to teaching; he continued until 1938, when at the age of 70, he was retired. In this period much time was enjoyably spent in an increasing amount of informal advisory work with students. In these years he also was active in Rotary work (District Governor of Rotary International in 1930–31) and in Masonic work, in lodge and commandary. He was a 32° mason. He was a member of the executive committee of the local hospital board for seventeen years and its president, for five.

Professor Dodge was strongly community-minded, highly desirous of being helpful. His office door was open to students, faculty, and public. As author and editor he sought constantly to make what he judged to be the best in geography both interesting and valuable to others. Many persons remember him appreciatively and regret his passing on April 2, 1952 in his 85th year.

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HERBERT ERNEST GREGORY, 1869–1952

S. S. VISHER

Dr. Gregory, president of the Association of American Geographers for 1920, died January 13, 1952 in his eighty-third year. He was a charter member of the Association. (There is now only one charter member living, C. C. Adams.) Gregory was a distinguished geologist, starred in *American Men of Science,* who attained prominence in geography as the director of the Bishop Museum of Honolulu, 1919–1936. He was an instructor or assistant professor of physical geography or physiography at Yale, 1898–1904, after which he was Silliman Professor of Geology. At Honolulu he encouraged scholarly studies in the Pacific partly by establishing Bishop Museum-Yale University Fellowships therefor. The present writer studied the tropical cyclones of the Pacific aided by such a fellowship, and the Museum published the resulting volume. Dr. Gregory also assembled the first Pan-Pacific Scientific Congress. These Congresses have proved distinctly stimulating to scientific studies of that region .

Dr. Gregory spent his childhood and youth in the sandhills section of northern Nebraska, although he was born in Middleville, Michigan, October 15, 1869. As a youth he was much interested in plants, animals, rocks, and minerals. The present writer's 1912 bulletin on the geography, geology, and biology of the badlands of South Dakota, an area almost adjoining Gregory's youthful home, was enthusiastically reviewed in *American Journal of Science,* and commenced our friendship.

Dr. Gregory was coauthor of a brief *Geography of Europe* used in officer training in World War I, and of Gregory, Keller, and Bishop, *Physical and Commercial Geography* (1910). His only paper in the *Annals* was "The Oasis of Tuba, Arizona" (V: 107–119). To the *Bulletin of the American Geographical Society* he contributed "The Navajo Country" (XLVII: 561–577). To *Economic Geography* he contributed "The Population of Southern Utah" (XXI: 29–57). Dr. Gregory's geological publications were numerous; the earlier ones included sizable papers on areas in Maine, Quebec, and Connecticut. He was superintendent of the Connecticut Geological and Natural History Survey, 1916–1919. Publications on the geology of the Southwest began to appear in 1911. In 1916 his bulletin on the geography and water supply of the Navajo country appeared as *U. S. G. S. Water Supply Paper 380* (219 pp.), and in 1917 the geology of that region was presented as *Professional Paper 93* of the U. S. G. S. (116 pp.). In 1918 appeared his "A Century of Geology: Steps in the Progress in the Interpretation of Land Forms" (*American Journal of Science,* XLVI: 104–132). This was revised as "History of Geology" (*Scientific Monthly,* XII: 97–126).

After Dr. Gregory retired at 65 as director of the Bishop Museum, he devoted considerable time to further studies of southern Utah, and produced several papers. These included "A Geologic and Geographical Sketch of Bryce Canyon National Park," *Zion-Bryce Museum Bulletin 4,* 36 pp. (1940); "Geology of Sevier River Valley, Utah," *American Journal of Science* CCXLII: 577–606 (1944); "Post-Wasatch Formations in S. W. Utah," *Journal of Geology* LIII: 105–115 (1945); "Scientific Exploration in Southern Utah," *American Journal of Science* CCXLIII: 527–549 (1945); "Zion National Monument, Utah" (coauthor), *Bulletin of the Geological Society of America,* LVIII: 211–244 (1947); "Geology and Geography of Central Kane County, Utah," *Bulletin of the Geological Society of America,* LIX: 211–247 (1948); and, finally, "Geologic and Geographic Reconnaissance of Eastern Markagunt Plateau, Utah," *Bulletin of the Geological Society of America,* LX: 969–977 (1949).

Dr. Gregory's career includes four chief epochs; first, that during which he was especially interested in biology. Next, for twenty years, he was an active worker in geology and a popular teacher at Yale. Of this period, Dr. C. F. Brooks writes, "Gregory was a pleasant, warm-hearted man with a good sense of humor He inspired confidence and greatly eased my adjustment to Yale when I became instructor there in 1915. He was an able lecturer. He organized his material well, and spoke unhurriedly in a pleasant voice. He had a striking appearance, with black hair, and penetrating eyes." Then for seventeen years he was the director of the chief museum in Hawaii and did much to stimulate and facilitate scientific work in the Pacific. The fourth phase was a return, after his retirement from the Museum, to field studies in the arid southwest and to writing about them. His contributions were substantial.

WILLIAM OSCAR BLANCHARD 1886–1952

JOHN L. PAGE

William Oscar Blanchard was born at Hilbert, Wisconsin on January 13, 1886, the son of Merritt and Mary Gaiter Blanchard. All three of his degrees were awarded by the University of Wisconsin, the Ph.B. in 1910, in Physics; and the Ph.M. in 1917 and the Ph.D. in 1921, both in Geography. However, his first two years of college, 1904–1906, were spent at Oshkosh Teachers College. He spent eight years as teacher, assistant principal, and principal in high schools in Wisconsin. While working toward the doctorate, Professor Blanchard held successively a fellowship, an assistantship, and an instructorship.

In the fall of 1921 William O. Blanchard was brought to the University of Illinois as an assistant professor to teach geography courses in the Department of Geology. He rose in rank rather rapidly, becoming associate professor in 1925, and professor in 1930. It was principally in the fields of Economic Geography and the Geography of Europe that he directed his interests in both teaching and writing. However, some of his attention was given to the preparation of "interest-stimulating devices" for primary and secondary school pupil and teacher. Of the more than one hundred entries which are in his total bibliography, one is a college textbook of which he was senior author, three are college workbooks, two are chapters of books at the college level, and two are Illinois Editions of grade school geographies. Most of the others are articles which have appeared in various journals published in this country.

Professor Blanchard spent the summer of 1925 in travel and study in southern and western Europe, and the school year 1931–1932 on a trip around the world while on the only sabbatical leave he took during the almost thirty-one years he was a member of the University of Illinois faculty. He taught summer sessions at Illinois 1922 through 1951, except for 1925 and three summers when he taught at the University of Iowa, Pennsylvania State College, and the University of Minnesota. He enjoyed teaching and was effective in presenting his subject matter.

For twenty seven years, William O. Blanchard was adviser to both undergraduate and graduate majors in geography. In this time he came to know many students who did much of their work under his guidance. To them he will be remembered as a man who was willing at all times to give encouragement, and to offer suggestions when he felt the student would be benefited thereby. To his colleagues, his mere presence and his kindness will be sorely missed.

He held membership in the Association of American Geographers, the National Council of Geography Teachers, the Illinois Academy of Science, Sigma Xi, and Gamma Alpha. In the Illinois Academy of Science he was especially active, having

presented papers at nineteen of the twenty-nine meetings held after he came to Illinois. He also strongly urged graduate students and younger members of teaching staffs to prepare and present papers on the Academy and other programs.

Professor Blanchard was active almost to the very time of his death, which came most unexpectedly on March 7, 1952. During the morning he met his regularly scheduled class and had planned to work in his garden, the pride of the neighborhood, in the afternoon. He received the Ellsworth Huntington Prize of 1952 posthumously for the following articles published in the Journal of Geography: "The Baltic Sea—Commercial Blind Alley," *Journal of Geography*, 1944 XLIII: 62–70; "The World's Greatest Inland Sea—The Mediterranean," *Journal of Geography*, 1950, XLIX: 232–238; and "The Narrow Seas," *Journal of Geography*, 1951, L: 221–230.

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REVIEWS AND ABSTRACTS OF STUDIES

LAND MANAGEMENT POLICY: THE ORGANIZATION PROBLEMS

Research on public land utilization problems and hence problems related to western land use in general has been handicapped for some time by the disorganized state of the published information as to the long range shifts in policy and public attitudes toward the public lands that have eventuated during the last half-century.

During the last decades of the 19th century public land policy, which only a little earlier had appeared so stable, was changing rapidly. The laws and programs were inefficient in implementing the old policy, but a new one had not yet evolved. Numerous situations which appeared to be different and new were causing perplexity as to the direction that land policies should take.

Even a superficial knowledge of political policies and power orientations with regard to public land questions is enough to convince an observer that national policy at present is something radically different from that which held the field somewhat over a half century ago. Beyond this it was difficult to go. The literature on the subject was fragmentary; discussing some particular phase of the problem, or analyzing the related events of a short period. But these studies all had a common weakness, a lack of perspective and continuity. It was like trying to determine what had been the outcome of a tennis match from the study of a few random snapshots of the event. What was imperatively needed was an overall review of the entire process of change. Such a study would be of importance in two respects. First of all, it would be of great interest in indicating the political processes whereby changes in land policy take place. But much more important for current research it would furnish perspective in which to view the present situation. Is it a passing phase of a trend? Is it a new, stable situation; or is it merely one side of an oscillatory, pendulum process repeating a similar pattern again and again?

During 1951, *The Public Domain: Disposal and Reservation Policies 1900–50*[1] was somewhat surreptitiously issued by its publishers. It would be an important volume, simply because it is the first attempt to close this major gap in our knowledge and concepts with respect to public land policy in the United States. But even if it becomes merely one of several volumes on this general topic it will still merit careful study. The author does not attempt to tell us what really happened. Perhaps despite the fact that it is an outgrowth of a doctoral dissertation, it has an explicitly stated thesis: "to relate, on the basis of the sources which are available, the steps by which the concept of the public domain has veered from one of land held in escrow pending transfer of title, toward one of reservations held in perpetuity in the interest of the collective owners, the people of the United States." (p. 5.) The entire volume is carefully oriented around this thesis. The materials introduced are those which the author felt were relevant to the problem; and interpretation, where it can be, is kept clearly separate from evidence. Moreover, it has the inestimable virtue of meticulous documentation. One may or may not agree with the interpretation of some data in the discussion, but it is possible to form ones own opinion by referring to either a particular source or a whole group of sources to which the author carefully directs her reader. The primacy of water problems to occupance of the West has been monotonously asserted and reiterated. Dr. Peffer, however, makes clear the reasons for this primacy and reveals its incredibly wide implications. The reviewer is not so rash as to attempt to paraphrase Dr. Peffer's concise and succinct treatment of this situation; and so, will content himself by asserting that the volume provides as clear an understanding of these relationships as is available elsewhere in the literature. Her presentation of the complete impasse of the cattle operator in trying to assemble legally a workable range unit, for example, seems the best available description of this situation, on which a veritable mound of literature has been produced. Substantially the reviewer can see few points on which the volume is vulnerable. Recognizing, then, that the implications of specific disagreements are a general concurrence with the author on the remainder of the

[1] Louise E. Peffer, *The Closing of the Public Domain: Disposal and Reservation Policies 1900–50.* (Stanford, California: Stanford University Press, 1951). ix and 372 pp.

volume, it is possible to raise certain critical considerations.

The author regards the Taylor Grazing Act as a "failure." (p. 332). It is difficult to determine exactly on what grounds the judgment is made. She asserts it is a "fact that it [The Taylor Grazing Act] has been rendered virtually useless except in protecting the interests of licensed graziers...." In general the objection seems to center in the power believed to reside in the district grazing advisory boards and in the National Advisory Board Council. It is recognized that the Act "could not have been made to function" without the co-operation of the stockmen. But this is not deemed a sufficient explanation, and a number of other political reasons are adduced to explain the rise of the Board's strength. Granting that the basic alignment of power is unquestionably oriented by political means, nevertheless, the non-political power of the stockmen is great and real. It rests on his control of tracts of key lands in an area of very complex land patterns (a fact of which the author is clearly aware.) This power is so great that the government agency administering grazing on the public lands *must* cooperate with the ranchers in order to achieve anything resembling an efficient program of land utilization. It is, in the reviewer's opinion, a mistake to suppose that a different political situation would greatly reduce the degree of cooperation necessary between government and ranchers in the administration of the grazing lands. The details of the situation vary considerably from area to area, but in general the situation is too well balanced to permit either group to dictate to the other.

To look at a single set of objectives and ignore all the other consequences of a land program is an indefensible general procedure, but conversely it is certainly reasonable to inquire whether or not the stated objectives have been attained. The Taylor Grazing Act had two stated objectives: "to stop injury to the public grazing lands" and "to provide for their orderly use."[2] Anyone who has done field work in the western range lands knows that these objectives have been partially attained. Over wide areas in the West the range lands are in better condition, (in some cases, far better condition) than they were in 1934. Others are in at least as good condition as they were in 1934. Comparatively few areas have deteriorated further in the last twenty years; which last could not be said prior to the passage of the Act. It is true that part of this improvement has resulted from the abnormal quantities of rainfall in the past fifteen years. It is equally true that almost all the induced improvement in the range has been the result of voluntary reductions in stocking by ranchers who, having exclusive grazing privileges on a piece of public range guaranteed by the Taylor Grazing Act, would reap the profits of any increase in forage production and improvement in the vegetation stand. But this phenomenon has not been simply a rational, automatic response to changed situation. A quiet, persistent educational program has been carried out by the District land managers while engaged in the routine of their administrative duties, which is responsible in no small part for the induced improvement that has taken place.

Viewed in the large, range utilization is "orderly." Shifts, realignments, and unsettled situations exist in every district, but they represent only minor, negligible, transitory disturbances in the much larger, stable area of settled conditions. Trespass is not uncommon. Overgrazing occurs sporadically in various places. Some overt conflicts in range claims and use exist, and the number of latent conflicts is enormous. But the areas of disorderly use are minute in proportion to the vast areas of smoothly organized range utilization. This seems implicit in Dr. Peffer's remarks about "protecting the interests of licensed graziers."

The present situation must be viewed not only in terms of conditions that would be desirable, but also with respect to the conditions that preceded the present ones.

The Taylor Grazing Act has not achieved its objectives in the ways that it was anticipated those objectives would be attained. Neither has it achieved all that was hoped or expected of it. What success has been achieved has been accompanied by some unexpected and undesirable consequences. But appraised in the light of conditions that preceded it, the improvement in range protection and orderly use brought about by the administration of the Taylor Grazing Act has been certainly something much better than "failure." In fact, considering the highly unfavorable political and social atmosphere that has existed throughout most of the life of the Act (an atmosphere which *The Public Domain* admirably describes and documents) the fa-

[2] 48 Stat. 1269.

vorable results of the Act might be considered as little less than remarkable.

The foregoing appraisal of the success achieved by the Taylor Grazing Act is, however, essentially a digression from the principal theme of this discussion. Suppose, that it is agreed with Dr. Peffer that the Grazing Advisory Boards have become very strong; stronger than they need to be. The alternative clearly indicated seems to be that the government shall be stronger. If we look at the matter in this light it readily becomes apparent that the whole question of the management of the public lands is merely one facet of the more inclusive problem of the organizational relationship between government and private individuals and private groups in the management of all the land resources of the United States. Throughout most of the twentieth century the only section of the United States in which this general problem had any specific importance has been the areas of extensive public lands in the West. Erich W. Zimmerman has perceived that "the East has always been willing to support conservation at the expense of the West . . .";[3] meaning, I take it, that whenever the East could be aroused to take any interest at all in the public lands question, it supported the federal bureaucracy in its plans to reserve, develop, and administer the lands still remaining under national ownership. This could always be done with the rather comfortable feeling that such matters were not of any paramount importance in any event; involving only some distant, low-value lands; a handful of people; not even any congressional votes of any importance, except occasionally in the Senate. The mass of the public, however, has about reached the end of the period when it will be able to maintain its detached attitude toward the organizational questions of land management, because the problem is invading the East. Actually, proposals to modify radically the organization of land management in the East were introduced as long as three decades ago. I predict that they will arise with increasing frequency and will be enlarged in scope to included an increasing proportion of the land area of the United States. There are numerous straws indicating the direction in which the winds are blowing. Intermittently for over thirty years it has been the official policy of the U. S. Forest Service to request police power over timber cutting in the United States on both public and private lands. The National Forests both eastern and western are being slowly but steadily enlarged by purchase and exchange. The area of National Parks and Monuments is slowly growing both east and west. What of the riparian lands on the hundreds of new reservoirs, the Department of Agriculture, The Corps of Engineers, and the Bureau of Reclamation intend to create? The President's Water Resources Policy Commission recommended that: "The necessity for public acquisition of areas which cannot be properly utilized and conserved under private ownership should be recognized."[4] A liberal interpretation of this recommendation could well be construed as a recommendation for governmental purchase of millions of acres of land throughout the country. I hurriedly add that no such notion was in the minds of the commissioners.

When the nation comes to face these questions on a national scale the great source of empirical data will be the experience of the last half century with the public land problems in the West. It has been a great laboratory of varied political, economic, and technical experiment, where private, state, and public power and interest have come together. It is this aspect of the public lands question that makes them of such importance and thereby imparts such importance to Dr. Peffer's study as to make its contents required reading for those who would understand the land management field.

The one facet of this land management problem that both the East and the West have been called upon to face squarely is that of the organization of administration and management of forest lands. Wherever, it has not been to difficult to do so, the general response has been to dispose of the policy problems involved by adopting the policy of doing nothing about the matter. But in many areas the situations that develop demanded novel solutions and active reorganization too imperatively to permit the problem to be evaded. The creeping blight of tax delinquency on the cut-over forest lands of the lake states; the widespread abandonment of land for agricultural use in the Northeast; the decline of the lumber indus-

[3] E. W. Zimmerman, *World Resources and Industries.* (New York: Harper and Bros., 1950). p. 504.

[4] President's Water Resources Policy Commission, *A Water Policy for the American People.* (Washington, D. C.: Government. Printing Office, 1950). p. 140.

try in the South; the obviously desolate future that would follow a cut-out and get-out policy in the Pacific Northwest; the importuning of the lumbermen to be allowed to cut the stumpage on the National Forests: these would not permit an evasion of the problems. And so on a national, a state, and a local level, organizational and policy experiments were undertaken; sometimes timidly and reluctantly, at other times with imagination and boldly. Over the years, a body of experience has been accumulating.

Two volumes have recently appeared which attempt an appraisal of the historical experience on these organizational and administrative questions with respect to forest lands, and each arrives at conclusions expressed either formally or informally as policy recommendations. Neither volume purports to attack the problem directly, and yet each volume ultimately concerns itself primarily with it.

American Forest Policy[5] by Luther Gulick approaches forest policy from the standpoint of public administration, and attempts to arrive at conclusions in answer to a broad general query about American Forestry: "how has the government sought to influence the economy, through what devices, with what results in administration and to the economy?" It is basically a broad summary of the whole of American forest policy: the problem, present policy, "new approaches to American forestry," and an appraisal of the over-all policy situation.

William B. Greeley in *Forests and Men*[6] much more informally reviews the past fifty years of American forestry in a semi-autobiographical volume. He is concerned more with real forests, personalities, organizations, and polictial battles. There is no thought of formal review and analysis of the American forestry problems.

In their general conclusions the two authors are not very far apart. Gulick, a student of public administration, feels that greater governmental authority is needed and desirable in forestry, but he recognized the necessity and desirability of integrated effort by government and private groups. Greeley (formerly chief of the Forest Service and for some years now associated with a major private forestry organization) recognized the interest and competence of the government; but he places major reliance on education and co-operation, "a growing understanding and a getting to work at the grass roots." If the foregoing description distorts the differences between the conclusions of these two writers, it errs by exaggerating the differences.

Very significantly, both books speak glowingly and approvingly of co-operation at the "grass roots." Neither author examines this concept of "grass roots" co-operation. This is the more surprising in Gulick's volume, because he includes a citation to Philip Selznick's[7] volume on the subject. Selznick has shown that the "grass roots" concept is by no means a simple one; and, moreover, that fundamentally differing types of relationships between the government and the persons and organizations at the "grass roots" can exist. In his discussion of "Grass-Roots Administration" (p. 224) Gulick draws up a reliable recipe for successful administration of this approach. But in the remainder of the volume the implications of the statement are not embodied in the recommendations and analyses. This is equally true of Greeley's discussions.

We may take a single illustration of the foregoing issue from Gulick. On page 231 he notes "that the whole [forestry] problem is still shot through with conflicts of interest even after fifty years. It is still a complex of pressures and politics." We might raise the question: with which of these conflicting groups will the government's representatives co-operate, and what will the form of that co-operation? Tugwell and Banfield[8] have raised a number of formidable general questions of this type, and have asserted that in many cases co-operation at the grass roots really transfers governmental authority to one of these conflicting groups. So cogent are their arguments and reasoning on these points that any recommendation for a 'grass roots" approach that does not specifically treat the problems they have raised may be viewed

[5] Luther Gulick, *American Forest Policy: A Study of Government Administration and Economic Control.* Published for the Institute of Public Administration by Duell, Sloan and Pearce. (New York, 1951). 252 pp.

[6] William B. Greeley, *Forests and Men,* (Garden City, N. Y.: Doubleday and Company, Inc., 1951). 255 pp.

[7] Philip Selznick, *TVA and the Grass Roots.* (Berkeley: University of California Press, 1949).

[8] R. G. Tugwell and E. C. Banfield, "Grass Roots Democracy-Myth or Reality?" (a review) *Public Administration Review,* Winter 1950.

somewhat dubiously. But, let us consider the implications of the statement on conflicts of interest in the light of another recommendation for a "comprehensive Master Land Use and Water Plan" for the continent as a whole (p. 124). In time "such a plan will be good enough to justify zoning of our total land resources by the several states." Land owners, lumbermen, and other local folk presumably can co-operate by assisting in carrying out the Master Plan even though they may have serious "conflicts of interest" with it. This is a highly particular definition of co-operation.

The illustration is not chosen either to support or deny the proposition, but rather to make the point that the local co-operation approach is not necessairly either useful or unproductive. It must be judged on its results in the individual instances where applied. In appraising such results attention needs to be directed not solely to the immediate objective but on its relation to the general success in achieving all desirable and related ends within the area. This is the greatest hiatus in land policy review.

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POPULATION OF SWITZERLAND

The Population of Switzerland. Kurt B. Mayer. New York: Columbia University Press, 1952.

This very interesting and valuable book presents a demographic picture of Switzerland from before 1800 to the present time. The final chapter covers a brief discussion of the estimated future populations and the population policy.

A very good list of sources is given covering the principal references in German, French, and English. A detailed 19 page index facilitates the use of this book. The text materials themselves are well documented and 89 documented tables appear throughout the book. One obvious fault, however, is the lack of a list of the titles of these tables. On the other hand, the titles of the 9 charts and the 4 maps are given in two separate lists following the Contents. The tables, largely computed for this book, provide a valuable mass of statistical data relating to the demographic patterns of Switzerland. Abundant use has been made of the statistics prepared for the various demographic studies published by the Office of Population Research, Princeton University.

This reviewer finds little if any reference to the present day distribution of population. More especially significant is the lack of a map showing where the people live today. Very little space is devoted to population totals by minor civil divisions. Part One covers briefly the growth of the Swiss population from before 1800 into the Twentieth Century. Part Two deals with the factors determining population growth; balance of births, deaths, and migrations. Part Three covers the characteristics and social structure of the Swiss population. In this section of the book recognition is given to the problems of age and sex distribution ratios, occupational groups and the various language and other ethnic groupings. Parts Four and Five cover migrations, international and internal. The final Part Six presents estimates as to the future population of Switzerland.

Except for the lack of a more complete treatment of the total population distribution today this book covers the essential demographic topics; and the author has applied these topics to a very important country, strategetically significant from its geographic situation and from its repeated neutrality position. The book is not only of value as a study of Switzerland, but it is a wonderful example of the type of study needed for each political unit of the family of nations. Only with a better understanding of the demographic structure of all countries of the world as related to the geographic patterns can a more complete realization be attained regarding the world's problems.

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A NEW GAZETTEER

The Columbia Lippincott Gazetteer of the World, edited by Leon E. Selzer with the geographical research staff Columbia University Press and with the cooperation of the American Geographical Society. x + 2148 pp. New York: Columbia University Press, by arrangement with J. B. Lippincott Company, 1952.

A gazetteer is indispensable to one who would roam the wide world and gain new horizons beyond the narrow confines of his native heath. Often one's roaming must be through the medium of written materials and then a gazetteer can be of great aid in providing accurate and concise information on unknown places mentioned in a text.

Although not as large as the old, but monumental, *Nouveau Dictionnaire de Géographie Universelle* by Louis Vivien de Saint Martin and Louis Rousselet (7 volumes, 1879–1895, plus 2 supplementary volumes, 1895–1900), *The Columbia Lippincott Gazetteer of the World* is by far the largest of the up-to-date world gazetteers. It contains about four times as much material as the only other up-to-date American world gazetteer, *Webster's Geographical Dictionary* (1949) (reviewed in these *Annals*, vol. XL. no. 2, June, 1952, p. 170) and about twice as much material as either of two older distinguished English-language gazetteers, its predecessor *Lippincott's New Gazetteer of the World,* edited by Angelo Heilprin (1905) or *Longmans' Gazetteer of the World,* edited by George G. Chisholm (1895).

The Columbia Lippincott Gazetteer of the World contains five and a half million words, 130,000 articles, and 30,000 cross-reference entries, all in a handy volume, 12 by 9 inches and a little over 2½ inches thick. Like many a gigantic compilation project it nearly foundered under the vast bulk of material to be handled. During the five-year period of its preparation 150 different people worked on it at one time or another. At mid-point in compilation, because of the high costs involved, it faced possible abandonment, curtailment of scope, or lowering of quality; at this critical juncture the Kresge Foundation stepped in and provided funds to continue the work. Although conceived originally as a revision of *Lippincott's New Gazetteer of the World,* this gazetteer is in fact entirely new. Theodore Shabad served as the assistant editor and John K. Wright, as an advisory editor.

It has three disadvantages in comparison with *Webster's Geographical Dictionary:* (1) The price of 50 dollars is so high that many individuals will feel unable to buy personal copies no matter how valuable the book may be. (2) In its avoidance of grouped entries it lacks the convenient data summaries of subdivisions of political units, such as provinces of a country or counties of a state, although cross-references are given to the separate entries for such subdivisions. (3) It has no maps containing the names included within a given area.

On the other hand it has four advantages: (1) It contains far more entries (130,000 compared to 40,000). (2) The information under a given entry often is somewhat fuller. (3) It puts greater emphasis on geographical aspects of the places treated in contrast to *Webster's* entries which contain proportionately more historical information. (4) Since entries are entirely in alphabetical order, information generally is quickly located directly under the name sought rather than under a grouped entry.

The gazetteer is remarkably up-to-date; its population figures, for example, include data from the 1950 census for the United States, preliminary data from the 1950 census for the Federal Republic of Germany, and preliminary figures from the 1951 census of England and Wales. A valuable feature is the "Key to Population Figures," which indicates for each country the date of the census from which population figures are taken.

A check by the reviewer of places in the Soviet Union indicates that for this country the gazetteer is strikingly superior to any other gazetteer both in the number of entries and in the scope, accuracy, and recency of information given under each entry. Further checks by half a dozen graduate students in geography on the areas in which they are doing research confirmed the superiority of this gazetteer over any other existing similar work. In the United States every incorporated place is included, and several thousand unincorporated ones.

The following entry on Magnitogorsk illustrates the scope and organization of material: "Magnitogorsk (American and Russian pronunciation indicated), city (30 square miles; 1929 population estimate 30,000; 1939 population 145,870; 1946 population estimate 200,000), SW Chelyabinsk oblast, Russian SFSR, on SW slope of MAGNITNAYA mountain (cross-reference indicated by capitals), on dammed upper Ural R. and 135 miles SW of Chelyabinsk, on S. Siberian RR (formerly W terminus of rail spur from Kartaly). The leading metallurgical center of USSR, based on magnetite mined at Magnitnaya mountain, iron ore and alloys from the Urals, and coal from Karaganda and Kuzbas. Stalin Steel Works (city's industrial giant; constructed

1931) consisted (1948) of 8 blast furnaces, 26 open-hearth furnaces, 2 blooming mills, 8 rolling mills, and 10 coke batteries; manufacturing (heavy and mining machinery, nitrate fertilizers, cement, clothing, shoes, foodstuffs). Has metallurgical and teachers colleges. Consists of several settlement nuclei established during construction period (1929) and merged into single urban center. Major industrial installations and temporary housing units are on left Ural R. bank. Construction of permanent residential sections on right bank of Ural R. reservoir began during Second World War (population expected to reach 270,000 upon completion of this project). Preliminary planning of Magnitogorsk (1929) was assisted by American engineers. Was boom town and major objective of Soviet industrialization plans in 1930s." (p. 1119). Similar entries give data on Oak Ridge, Tenn. (p. 1360) or Hanford Works (cross-reference to Richland village, Wash.). On irrigation and water power projects, for example, data are given for the Colorado–Big Thompson project under Alva B. Adams Tunnel, Granby, Big Thompson River, and Colorado River; for the Volga–Don Canal; for the Turkmen Canal; for the hydroelectric plant on Loch Lomond, etc.

The Columbia Lippincott Gazetteer of the World should serve as a standard library reference gazetteer, since it is the most comprehensive and for most purposes the best of the gazetteers covering the entire world as it exists after the Second World War.

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CARTOGRAPHY

Maps and Diagrams: Their Compilation and Construction. F. J. Monkhouse and H. R. Wilkinson. London: Methuen & Co., Ltd., 1952.

Maps, graphs, and other types of diagrams are among the most useful tools of geographers. With their aid many space and time relationships can be represented graphically, and as a result geographic description can be made clearer and more vivid and geographic analysis can be made more penetrating.

In order to achieve these results the geographer must first become acquainted with the data of one or more of the specific phases of geography—climatology, economic geography, the study of population, for example. He must learn how to go about acquiring primary data, such as actual temperature and rainfall, himself if necessary; and he must know where he can find primary data that have been acquired by others, and how to compute derived data, such as mean daily temperature or net reproduction rate of population. He must then learn how to select the best types of maps and graphs for the persentation of such data. Finally, some knowledge of actual drafting techniques is desirable. The geographer need not necessarily become a skilled draftsman himself, but he should at least know enough about the problems involved so that he may direct someone else intelligently in the making of his maps and diagrams.

Here, then, are three fields in which the geographer must acquire some degree of competence, and training in these fields is the aim of the book, "Maps and Diagrams," by F. J. Monkhouse and H. R. Wilkinson. Is it possible for a single book to do this adequately? Obviously the answer must be no. To become acquainted with the data of climatology, for example, is a large project in itself, involving among other things the study of how to measure the various climatic elements; how to find the measurements of other workers; how to analyze these data and from them compute other data, such as intensity of rainfall, indices of aridity, etc. It is impossible in one chapter, 60 pages long, to deal with these matters adequately and at the same time to discuss methods of presenting climatic data by means of maps and graphs. The same is true of relief, economic geography, population, and settlements, the other general topics to which chapters are devoted. (The first chapter deals with materials and techniques.) And of course these represent only some of the numerous topics included in the broad field of geography. No one book could do justice to them all. Nor will any one student be interested or qualified in all of them. Why not, then, assume that the student will acquire the information he needs about climatology, economic geography, etc., elsewhere, and let a book on maps and diagrams concentrate on training him in the best use of the different kinds of maps and diagrams, and in some of the techniques of their construction?

Even this is a large order, but it is a type

of training much needed by geographers, and Monkhouse and Wilkinson have made a valuable contribution toward it. Many types of maps and diagrams are discussed, with notes on their most advantageous use and on problems met with in their construction. There are numerous references to examples in geographic literature, and many examples are reproduced. However, because of the topical approach, noted above, these discussions are usually scattered through the book. Isopleths, for example, are dealt with in every chapter. Proportional symbols are discussed at length in the chapters on materials and techniques, economic geography, and population, and more briefly in the chapter on climatology. Some repetition is thus inevitable, and the reader must search through the book to find all the pertinent material on any given type of map or diagram. There is some discussion, much needed by young geographers and cartographers, of the problems of preparing maps for publication—for example, the problem of legibility after reduction—but this material also is scattered. Were it brought together and given greater emphasis it would be more effective. Little information is given on methods of preparing multicolored maps for reproduction, and color (red combined with black) is used in only seven of the book's 199 illustrations.

Two omissions must be noted with regret: (1) There is no discussion of map projections, which the authors explain in the preface by saying that "the scope of cartography is so vast that no apology is needed for a selective approach." In view of the aims of the book this may be true enough as regards the history of cartography and practical surveying, two other topics the authors have purposely omitted. But training in the use of maps is certainly incomplete without some reference to map projections. In planning a map the choice of the most suitable projection is one of the first decisions to be made. Details of construction of the different projections may not be needed, but certainly it is necessary to know the advantages and disadvantages of some of the more common projections, or a very unwise choice may be made. (2) No examples are cited of the use of maps for the correlation of geographic data. Correlation is often one of the most important contributions of geography, and maps are among the most important tools for correlation. A book concerned "with the training of geographers," as is this one, ought not to neglect this important use of maps.

Since the book was written and printed in England it presents certain problems and surprises for American readers. The drafting materials and instruments mentioned in the chapter on materials and techniques are all of English make and are generally not procurable in the United States. The table of scale conversions on page 11 may be quite adequate for English geographers, but it omits scales in common use in the United States, such as 1 : 62,500 and 1 : 250,000. Some of the techniques suggested will also seem strange to Americans. For fine work the authors recommend both goose and turkey quills. In the United States the use of quills, common in the last century, has gone with the bustle. In contrast, the use of type for map names is not advocated, whereas most map makers in this country now use type. Some good examples of its use can be seen on recent maps published by the American Geographical Society. In the section on relief maps, no mention is made of the method of photographing three-dimensional relief models to obtain accurate representation of relief by shading. Examples of maps reproduced in this way can be found in the "Weltatlas," a school atlas published in 1947 by Karl Wenschow in Munich. While a goodly number of American works are cited as examples, there are some prominent omissions—for example, the physiographic diagrams of A. K. Lobeck and Guy-Harold Smith, and Mark Jefferson's graphs of daily temperature range. Among recent American works that might well have been cited one of the most outstanding is Arthur N. Strahler's "Physical Geography," in which there are many original and very effective diagrams.

It must be remembered, however, that the subject of maps and diagrams is a vast one, and it would be difficult to include in one book all that every reader would like to find there. To geographers, and to all authors who use maps and diagrams, the many examples presented by Monkhouse and Wilkinson should prove stimulating, and the book should be of great value as a guide in the preparation of black and white maps and diagrams.

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